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# Telephotometric Study of Baseline Visual Range at Cedar Mountain, Utah, July 7 to August 6, 1978

(U.S.) National Oceanic and Atmospheric Administration, Boulder, CO

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# TELEPHOTOMETRIC STUDY OF BASELINE VISUAL RANGE AT CEDAR MOUNTAIN, UTAH JULY 7 TO AUGUST 6, 1978

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Boulder, Colorado
June 1979

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16. ABSTRACT
Visual range values derived from telephotometric measurements at Cedar Mountain, Emery County, Utah, from July 7 through August 6, 1978, are presented. Concurrent values of visual range were also determined and reported. Comparison of the visual range obtained by the two methods is discussed. After correction of visual range calculations, the photographic values are about 20 percent less than the telephotometric values of visual range. A system of linear corrections of the photographic visual range was devised so that photographic values can be converted to correspond to telephotometric values. Converted values of photographic visual ranges have a smaller standard deviation that that of the concurrent telephotometric values, indicating that extremely high and low values of photographic visual range would not be accurately converted to equivalent telephotometric values. Average values of photometric and telephotometric visual ranges would agree within a few percent. (Author extracted)

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## FOREWORD

The visual range study described herein was performed by the U. S. Department of Commerce National Oceanic and Atmospheric Administration under an interagency agreement with the U. S. Department of Interior Bureau of Land Management and the U. S. Environmental Protection Agency. This data report constitutes a progress report covering the July 7 to August 6, 1978, observational period.

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# TELEPHOTOMETRIC STUDY OF BASELINE VISUAL RANGE AT CEDAR MOUNTAIN, UTAH--JULY 7 TO AUGUST 6, 1978

Paul A. Allee and L. Gwen Lowery

## 1. INTRODUCTION

This data report presents visual range values derived from telephotometric measurements at Cedar Mountain, Emery County, Utah, from July 7 through August 6, 1978. The primary results are presented for the visual ranges of four views. Other studies related to the visual range are also considered. Concurrent values of visual range were also determined and reported from the photographic method under a contract agreement (No. 0307-022-35107, dated November 11, 1976) between the National Oceanic and Atmospheric Administration, Boulder, Colorado, and the Martin Marietta Corporation, Denver, Colorado. Martin Marietta furnished the film, film processing, film densitometry, data reduction, data analysis, and reporting of the photographic visual range for four views on Cedar Mountain, Utah. Comparison of the visual range obtained by the two methods is discussed within this data report.

## 2. HORIZONTAL VISUAL RANGE

### 2.1 The Concept of Visual Range

The measurements and discussion of horizontal visual range in this data report are restricted to daytime values of the visual range. It is defined (Glossary of Meteorology, 1959) as the distance under daylight conditions, at which the contrast between a specified type of target and its background becomes just equal to the threshold contrast of an observer. Contrast is the ratio of the apparent luminance of the target, minus that of its background, to the apparent luminance of the background. This is expressed as

$$C' = \frac{B_b - B_h}{B_h} \qquad (1)$$

where C' is the contrast, $B_b$ is illuminance of the target, and $B_h$ is illuminance of the background, or, in this study, the illuminance of the horizon sky directly above the target. The contrast is negative if the

target is darker than its background, positive if the target is lighter. Fig. 1 is an illustration of the relationship between the observer, the target, and atmospheric conditions relating to the visual range. Threshold contrast is the smallest contrast (or liminal contrast) of luminance (or brightness) that is perceptible to the human eye under specified conditions of adaptation of the eye to the luminance of nearby objects and the angle subtended by the target. Objects either so close or so large, or both, that they shade an appreciable portion of the observer's vision decrease the amount of light entering the eye and increase its brightness contrast, thereby increasing the visual range. Large targets (10°) can be seen farther away than small targets (2°). Objects subtending visual angles of less than 0.5° are more difficult to detect because of the increased threshold contrast required for detection. Targets used in this study subtended angles of about 0.5°.

Threshold contrast varies from one observer to another under fixed external conditions. It tends to increase with decreasing adaptation illuminance, and with decreasing target visual angle below about 1°. An overall absolute value of the threshold contrast range is from about 0.005 to 5.0 for all observing conditions. A value of 0.02 is used in this study as being the approximate contrast value to be found during daylight when a mountain target is viewed with a visual angle of about 0.5°. The contrast value of 0.02 was usually confirmed with telephotometric measurement of visual range when mountain ranges at 72 and 110 miles were barely visible under daylight conditions.

Middleton (1952) lists simplifying assumptions attributed to Gruner and Koschmeider that are necessary to develop the theory of visual range of a black target against a lighter background:

1. The atmosphere is considered a turbid medium, containing a large number of small particles.
2. Each element of volume contains a very large number of particles, each of a much smaller order of magnitude than the element itself.
3. The scattering action of each particle is independent of the presence of all the others.
4. The light scattered from an element of volume originates from a point source of which the intensity is proportional to the number of particles.
5. Light rays are considered rectilinear, i.e., atmospheric refraction is neglected.
6. A cloudless sky is assumed.
7. The coefficient of attenuation by scattering, b, is constant in a horizontal plane, in particular near the surface of the earth, where it takes the value $b_0$.
8. The curvature of the Earth is neglected, and its surface is considered to be a diffusely reflecting horizontal plane.
9. The linear dimensions of the whole observed object are small in comparison to its distance from the observer.

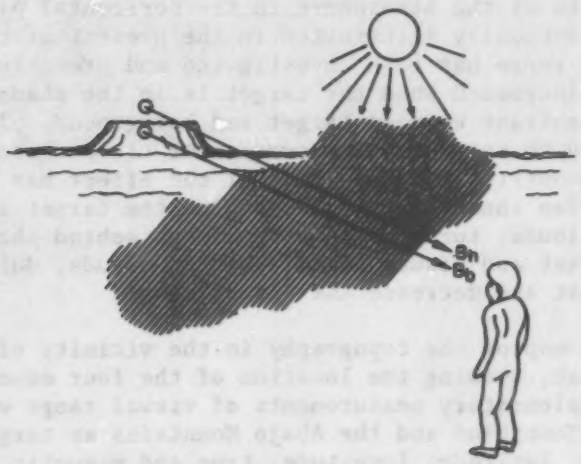


Figure 1. Observations for determining the visual range. $B_b$ is the luminance of the target mountain, $B_h$ the luminance of the horizon sky above the target. The contrast ratio between the target luminance and the sky luminance is decreased by light scattered from air molecules and particles suspended in the atmosphere between the observer and the target.

Some of these assumptions need additional comment with respect to the field site conditions at Cedar Mountain, Utah. The targets are not true blackbody objects. The north target (NT) is mostly covered with evergreen trees and its albedo changes little with the seasons. The east target (ET) luminance is measured on an area covered with aspen trees that are leaf-covered in summer, and during winter the slope of the target is so shallow that the tree trunks block a view of the snow-covered ground; therefore, the albedo does not change much with the seasons. The south target (ST) and west target (WT) have very steep slopes, sparsely covered with juniper and piñon pine trees. Heavy snowfall accumulates on these steep slopes and the albedo changes in winter. The albedo of the ST and WT, being greater than for the NT and ET, would lead to less contrast between the target and the sky and would tend to give lower values of visual range when the target is sunlit.

The other assumptions are well met in Utah. The coefficient of attenuation by scattering (item 7) has been measured with a nephelometer in an aircraft flying along the line of sight and there has been found no significant variation of the coefficient of attenuation along that line of sight.

Not all parts of the atmosphere in the horizontal plane along the line of sight are equally illuminated in the present of clouds. This aspect of visual range has been investigated and presented in Sec. 3.5. Visual range is increased when the target is in the shadow of a cloud, increasing the contrast between target and background. The phenomenon has been observed to occur during movement of cloud shadows across the target, but no quantitative assessment of the effect has been studied during a short time interval. Clouds behind the target affect visual range. Summer clouds, turrets of white clouds behind the targets, increase the contrast and visual range. Winter clouds, dull gray stratus, lower the contrast and decrease the visual range.

Fig. 2 is a map of the topography in the vicinity of Cedar Mountain, Emery County, Utah, showing the location of the four mountain peaks used as targets. Supplementary measurements of visual range were measured using the Henry Mountains and the Abajo Mountains as targets. Table 1 records altitude, latitude, longitude, true and magnetic bearings, and distance from Cedar Mountain (CM) and the six mountain peaks used as visual range targets.

## 2.2 The Theory of Visual Range

By referring to Middleton (1952) and Harrison (1945) the relationship depicted in Fig. 1 between visual range and the illuminance of the target, $B_b$, and the horizon sky, $B_h$, can be derived.

$\underline{i}$ is the daylight flux on a unit volume of the column of air between the target and the observer, and $\sigma$ is the attenuation coefficient of the air, considered to be homogeneous. Of the energy going through the unit volume a fraction $\underline{a}$ of the energy is scattered toward the observer. The flux of illumination from an element $\underline{dx}$ toward the observer will be $\underline{aidx}$, and the amount reaching the observer will be $\underline{aiexp(-\sigma x)dx}$. The brightness b of a black body at a distance d will be the total flux reaching the observer from all elements of the column from distance $\underline{d}$ to the observer, or

$$b = \int_0^d \underline{aiexp(-\sigma x)dx} = \underline{ai}(1 - \exp(-\sigma d)) \quad . \qquad (2)$$

Similarly for the brightness of the horizon sky, h, above the target

$$h = \int_0^\infty \underline{aiexp(-\sigma x)dx} = \frac{\underline{ai}}{\sigma} \quad . \qquad (3)$$

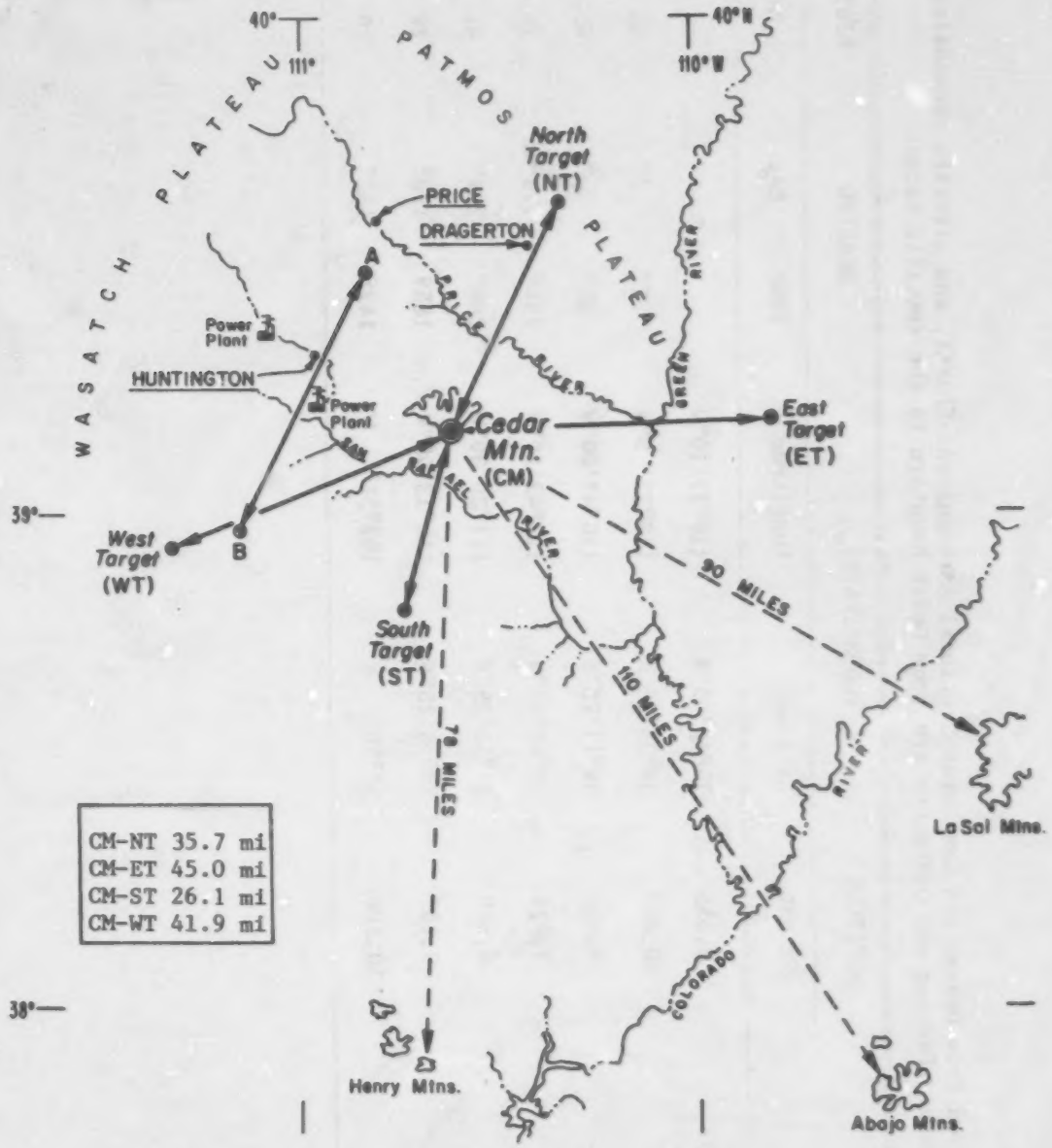


Figure 2. Topography in the vicinity of Cedar Mountain, Emery County, Utah, showing the location of the four mountain peaks, the Henry Mountains and the Abajo Mountains that were used as targets to determine the visual range.

Table 1. Data derived from Denver and Las Vegas Sectional Aeronautical Charts, and aircraft reconnaissance flights. Bearing and distances are from Cedar Mountain to the specific target.

| LOCATION | ALTITUDE | COORDINATES | | BEARING | | DISTANCE |
|---|---|---|---|---|---|---|
| | Ft MSL | Latitude | Longitude | True | Mag. | Miles |
| Cedar Mountain (CM) | 7,655 | 39°10'25"N | 110°37'10"W | | | |
| North Target (NT) | 10,000 | 39°39'25"N | 110°22' 5"W | 22° | 7° | 35.7 |
| East Target (ET) | 9,510 | 39°11'25"N | 110°47'00"W | 88° | 73° | 45.0 |
| South Target (ST) | 7,425 | 38°48'25"N | 110°43'20"W | 194° | 179° | 26.1 |
| West Target (WT) | 8,600 | 38°55'25"N | 111°20'30"W | 246° | 231° | 41.9 |
| Henry Mountains | 9,187 | 38° 8'25"N | 110°13'45"W | 185° | 170° | 72.0 |
| Abajo Mountains | 10,500 | 37°50' N | 109°31' W | 147° | 132° | 110 |

Putting this value of h into Eq. 2,

$$b = h\,(1-\exp(-\sigma d)) \quad .$$

This can be written

$$\ln\left[\frac{1}{1-b/h}\right] = \sigma d \quad . \tag{4}$$

If a liminal contrast ratio of 0.02 is assumed, then

$$C' = .02 = \frac{B_b - B_h}{B_h} \ ,$$

and if $B_h = 1$,

then $B_b = .98B_h$ .

Since $b = B_b$ and $h = B_h$,

from Eq. 4 we have

$$\ln\left[\frac{1}{1 - .98B_h/B_h}\right] = \sigma d, \text{ or} \tag{4a}$$

$$d = \frac{\ln 50}{\sigma} = \frac{3.912}{\sigma} \quad . \tag{5}$$

If a target viewed at distance r has the illuminance $B_b$, and the sky above has the illuminance of $B_h$, then from Eq. 4

$$\sigma r = \left[\frac{1}{1 - B_b/B_h}\right],$$

or $$\sigma = \frac{1}{r} \ln\left[\frac{1}{1 - B_b/B_h}\right] \quad . \tag{6}$$

Putting the value of $\sigma$ from Eq. 6 into Eq. 5, assuming $\sigma$ is the same over distance d and r,

$$d = \frac{3.912r}{\ln(1 - B_b/B_h)} = \frac{-3.912r}{\ln(1 - B_b/B_h)}$$

In this report the visual range is denoted as $V_r$, where r is the distance to the respective target, and

$$V_r = \frac{-3.912r}{\ln(1 - B_b/B_h)} \quad (7)$$

## 2.3 Telephotometric Method

$B_b$ and $B_h$ were measured directly with a Gamma Scientific, Inc., Model 2009 Auto-telephotometer. The optical head used a 200-mm objective lens with a viewing eyepiece to locate the target. A fiber optic with a 6-min aperture was placed on the target image at locations shown in Figs. 3, 4, 5, and 6. These figures show the location at which densitometer readings on the film were taken when the photographic method for determining $V_r$ was used. The telephotometer readings were made on the same location. The 6-min fiber optic is set in the equipment so that there appears to be a ring around the fiber of approximately twice the fiber diameter. This ring was set tangent to the horizon above and below to measure $B_h$ and $B_b$, respectively. When tested with a cardboard mockup of field conditions and illuminated with sunlight, the telephotometer gave the same reading above and below the cardboard "horizon", simulating field measurements, and for measurements when the field of view was completely filled with the "sky" or "target". The test indicates that any light scattering within the telephotometer lens system is negligible. The fiber optic transmits the light to a photomultiplier tube. The detector has an S11 photosurface spectral response that is corrected by a filter to a photopic (human eye) response. Three values of $B_b$ and $B_h$ were measured during the observation of a target to assure that there was no rapid change of illuminance during the observation period. Since there would have been a slight change of calibration if $B_b$ and $B_h$ were measured on different readout scales of the telephotometer, readings were always taken without changing scale. If necessary a neutral filter was introduced into the detector system so that $B_b$ and $B_h$ would be read on the same readout scale.

## 2.4 Photographic Method

The photographic method of determining $V_r$ used an Olympus OM-1 camera coupled to a Celestron 8 lens, focal length 2000 mm, f10, Schmitt-Cassegrain type construction. The film used was Kodak Panatomic X, black and white, ASA 32. A densitometer was used to measure the density of the target and horizon sky images on the developed negative. From densitometric calibration of the film and its characteristic curve the

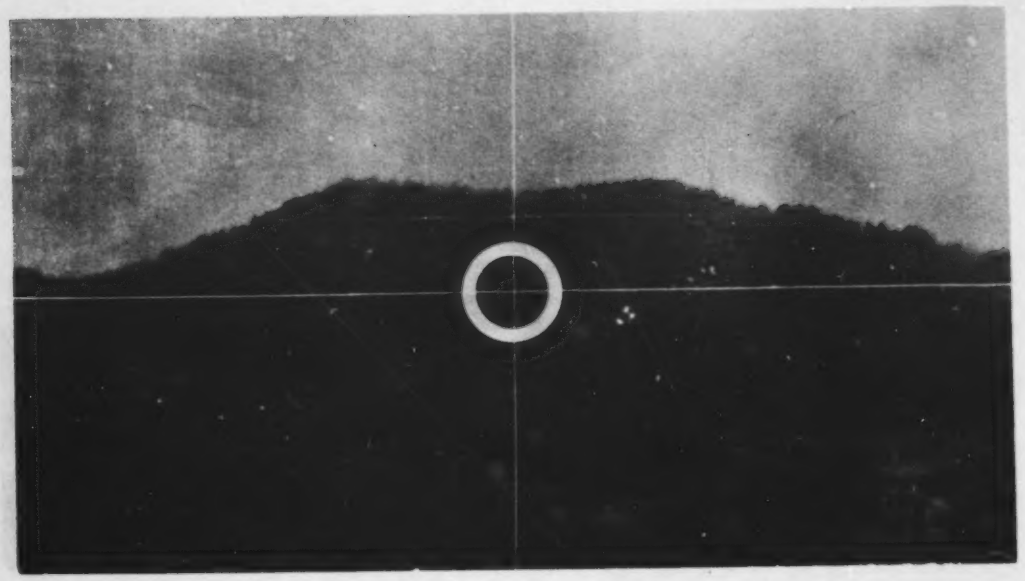

Figure 3. North target.

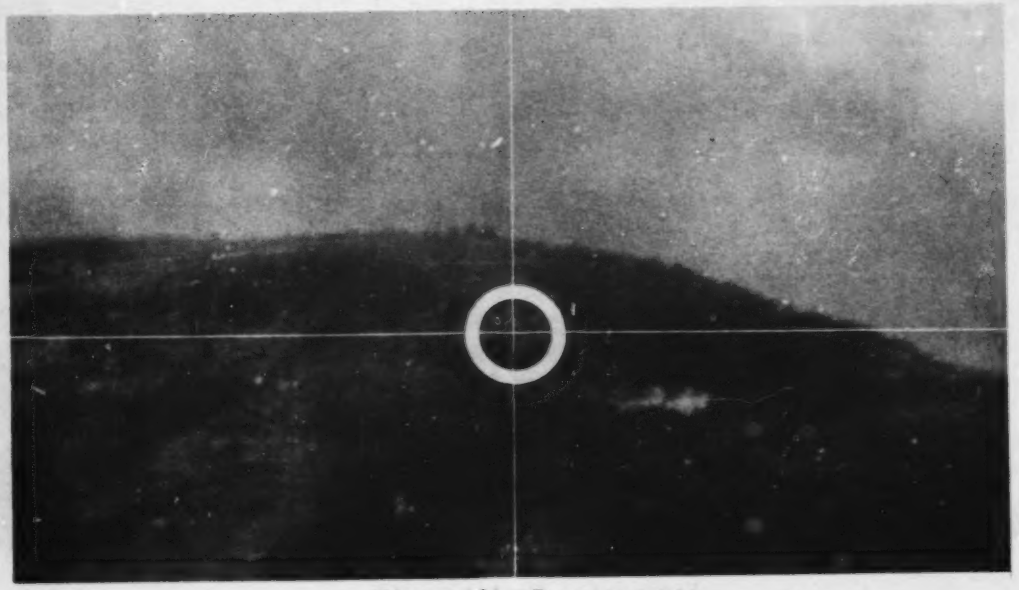

Figure 4. East target.

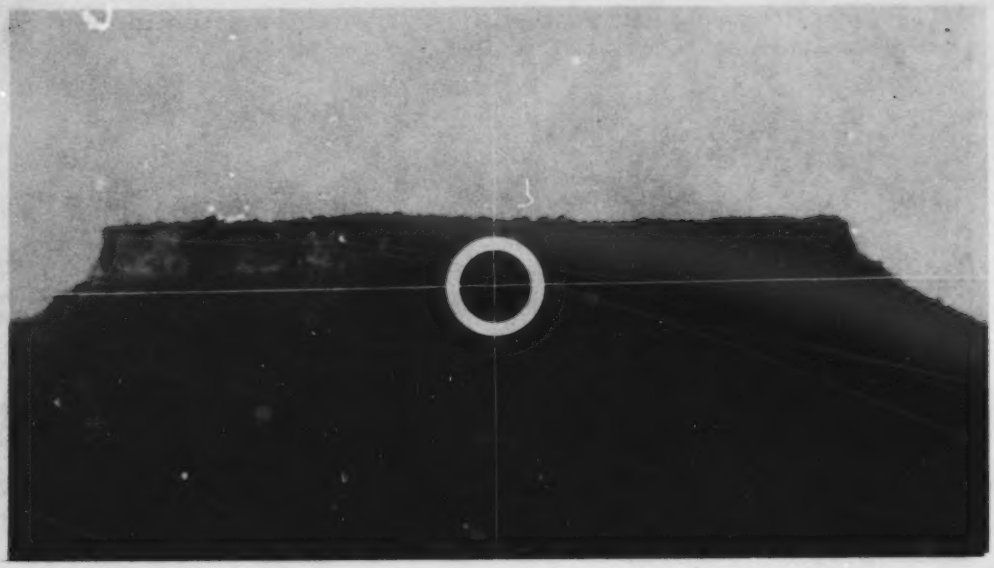

Figure 5. South target, Block Mountain.

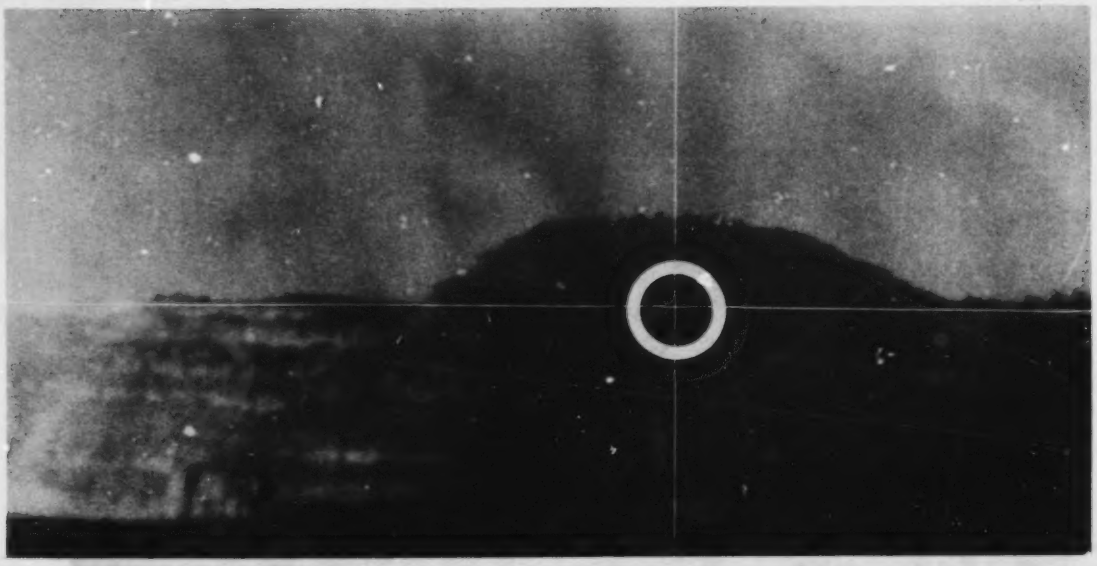

Figure 6. West target.

relative illuminance of the target and sky can be determined. Visual range can then be calculated using Eq. 7.

## 3. RESULTS

### 3.1 Average Hourly Values of Telephotometric Visual Range

The NT and ET visual ranges, sky behind target (SBT), have high values in the morning at 0800 MST, decrease about 15 percent during the day and recover to slightly higher than the 0800 MST value by 1600 MST.

The ST and WT visual ranges, SBT, are lower than NT and ET visual ranges at 0800 MST by 30 to 40 percent and increase until by 1600 MST the WT visual range is the highest value for any target during the day.

Data are to be found in Tables 2 and 3, and presented graphically in Fig. 7. For clouds behind target (CBT) NT visual range increases for two hours, decreases until midday, then increases during the afternoon. ET visual range decreases from morning values, then remains relatively constant with minor variations. ST visual range values, with variations, increase some during the day. The WT visual range starts the morning with the lowest of all, and increases by about 40 percent during the day.

The average hourly values for an overall view of four targets, SBT and CBT, are presented in Fig. 8. Morning visual range values are relatively constant, with a 10 percent increase during afternoon hours. SBT values are greater than CBT values of visual range, excepting the 1100 MST value. The reason the CBT exceeds the SBT value at 1100 MST is unknown. A study in progress indicates that visual range is inversely related to the relative humidity. Weather conditions that produced clouds behind the mountain targets would be expected to have higher concentrations of water vapor (relative humidity) in the atmosphere. Light scattering particles in the atmosphere that were directly size-sensitive to increased water vapor concentration by reason of absorption of water and subsequent growth in size would scatter more light into the optical path. (See also Sec. 3.5.)

### 3.2 Classification of a Day as SBT or CBT

Three days during the observation period were clear, with only sky behind the target (SBT). Fig. 9 shows the percentage of observations taken during a day that had no clouds behind the target. Two days had clouds behind all targets at all observations. All other days were between these extremes. The days were classified as clear if more than 50 percent of the observations had sky behind target, cloudy if more than 50 percent

Table 2. Data for views from Cedar Mountain, Emery County, Utah, with sky behind target.

| TARGET | | NORTH | EAST | SOUTH | WEST | OVERALL |
|---|---|---|---|---|---|---|
| HOUR | | | | | | |
| 8 | N | 18 | 17 | 15 | 19 | 69 |
| | $V_r$ av. | 111.9 | 114.0 | 87.4 | 78.2 | 97.8 |
| | σ | 14.7 | 16.7 | 9.3 | 11.0 | |
| 9 | N | 16 | 16 | 15 | 17 | 64 |
| | $V_r$ av. | 107.0 | 111.6 | 88.9 | 82.5 | 97.4 |
| | σ | 11.4 | 15.6 | 7.6 | 13.3 | |
| 10 | N | 17 | 16 | 13 | 15 | 61 |
| | $V_r$ av. | 102.8 | 108.4 | 94.2 | 79.9 | 96.8 |
| | σ | 11.2 | 11.3 | 7.1 | 7.1 | |
| 11 | N | 11 | 17 | 17 | 14 | 59 |
| | $V_r$ av. | 100.3 | 104.6 | 97.5 | 85.3 | 97.2 |
| | σ | 10.4 | 10.1 | 10.6 | 7.4 | |
| 12 | N | 7 | 14 | 14 | 11 | 46 |
| | $V_r$ av. | 99.9 | 101.8 | 100.1 | 87.1 | 97.5 |
| | σ | 9.9 | 11.1 | 10.7 | 9.9 | |
| 13 | N | 5 | 11 | 8 | 8 | 32 |
| | $V_r$ av. | 100.5 | 99.1 | 105.1 | 96.5 | 100.2 |
| | σ | 13.6 | 11.1 | 11.7 | 14.8 | |
| 14 | N | 3 | 11 | 7 | 8 | 29 |
| | $V_r$ av. | 94.3 | 101.3 | 106.8 | 101.5 | 102.0 |
| | σ | 25.9 | 14.6 | 9.3 | 14.4 | |
| 15 | N | 5 | 11 | 6 | 8 | 30 |
| | $V_r$ av. | 107.4 | 107.4 | 109.9 | 113.7 | 109.6 |
| | σ | 8.2 | 14.5 | 9.8 | 6.6 | |
| 16 | N | 6 | 8 | 5 | 7 | 26 |
| | $V_r$ av. | 115.9 | 110.0 | 109.0 | 117.8 | 113.3 |
| | σ | 9.3 | 12.6 | 9.2 | 10.2 | |

Note: N = number of hourly observations
σ = Standard deviation.
$V_r$ av. = Average visibility (miles).

Table 3. Data for views from Cedar Mountain, Emery County, Utah, with clouds behind target.

| TARGET | | NORTH | EAST | SOUTH | WEST | OVERALL |
|---|---|---|---|---|---|---|
| HOUR | | | | | | |
| 8 | N | 6 | 7 | 6 | 5 | 24 |
| | $V_r$ av. | 99.0 | 110.1 | 92.4 | 63.7 | 93.3 |
| | σ | 19.2 | 19.8 | 18.1 | 4.6 | |
| 9 | N | 8 | 8 | 8 | 7 | 31 |
| | $V_r$ av. | 103.2 | 113.6 | 86.0 | 63.5 | 92.5 |
| | σ | 25.9 | 17.2 | 16.1 | 9.5 | |
| 10 | N | 8 | 9 | 11 | 11 | 39 |
| | $V_r$ av. | 110.4 | 99.3 | 90.0 | 72.7 | 91.5 |
| | σ | 15.3 | 14.0 | 17.0 | 12.2 | |
| 11 | N | 14 | 8 | 7 | 11 | 40 |
| | $V_r$ av. | 104.2 | 104.3 | 97.4 | 87.2 | 98.4 |
| | σ | 21.6 | 14.8 | 23.1 | 20.6 | |
| 12 | N | 18 | 10 | 9 | 12 | 49 |
| | $V_r$ av. | 104.6 | 102.0 | 96.0 | 82.2 | 97.0 |
| | σ | 18.0 | 14.6 | 12.6 | 14.3 | |
| 13 | N | 19 | 14 | 15 | 17 | 65 |
| | $V_r$ av. | 97.7 | 103.4 | 91.9 | 88.6 | 95.2 |
| | σ | 22.7 | 15.4 | 22.1 | 17.7 | |
| 14 | N | 21 | 13 | 16 | 14 | 64 |
| | $V_r$ av. | 100.3 | 105.6 | 89.1 | 97.7 | 98.0 |
| | σ | 22.9 | 12.9 | 26.4 | 12.1 | |
| 15 | N | 18 | 13 | 17 | 15 | 63 |
| | $V_r$ av. | 106.8 | 100.1 | 98.8 | 103.2 | 102.4 |
| | σ | 24.3 | 20.8 | 25.0 | 15.6 | |
| 16 | N | 18 | 17 | 17 | 16 | 68 |
| | $V_r$ av. | 114.8 | 104.9 | 98.8 | 103.9 | 105.8 |
| | σ | 30.3 | 19.5 | 20.7 | 16.3 | |

Note: N = Number of hourly observations.
σ = Standard deviation.
$V_r$ av. = Average visibility (miles).

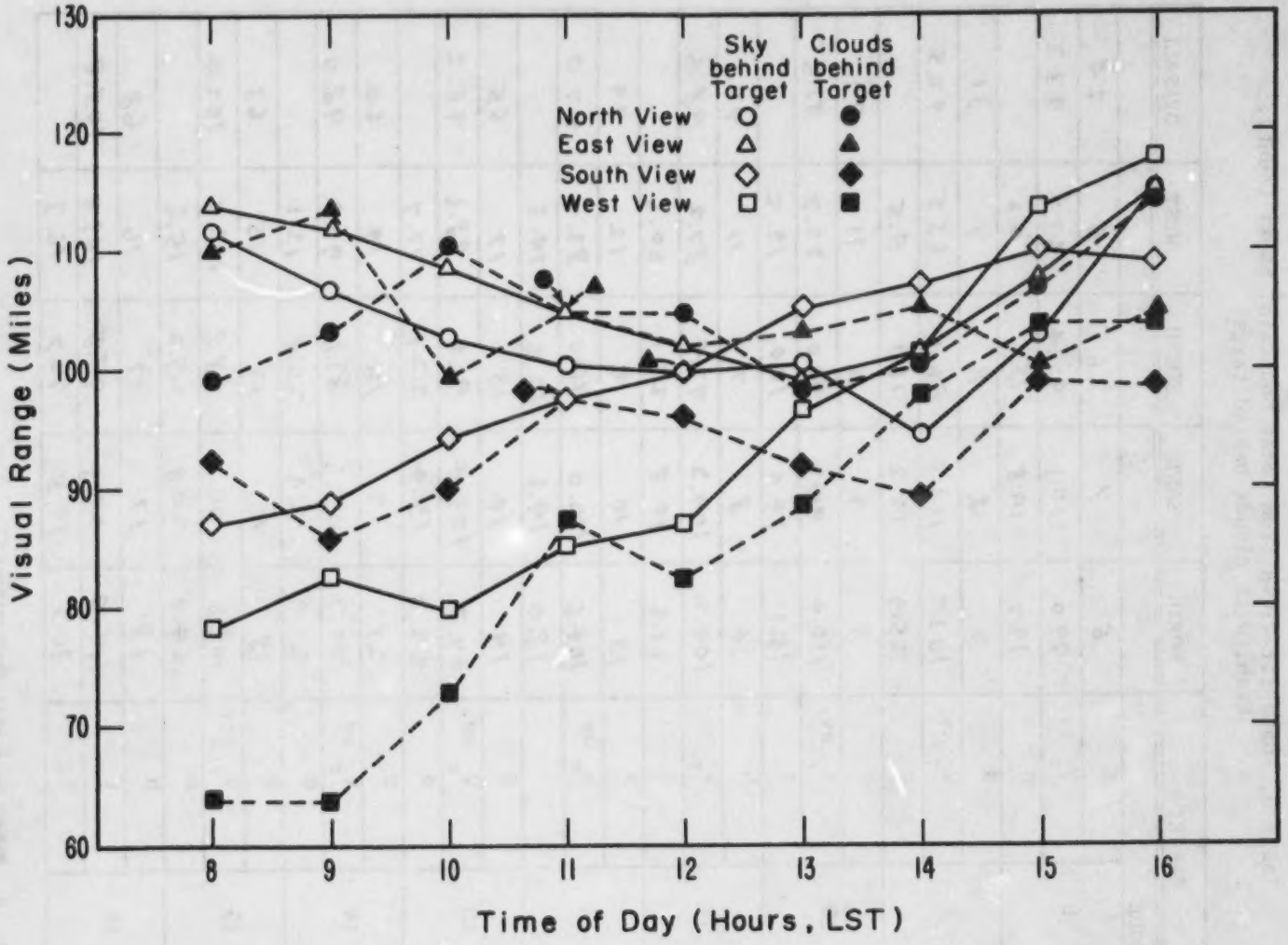


Figure 7. Average hourly visual range for four views, Cedar Mountain, Utah.

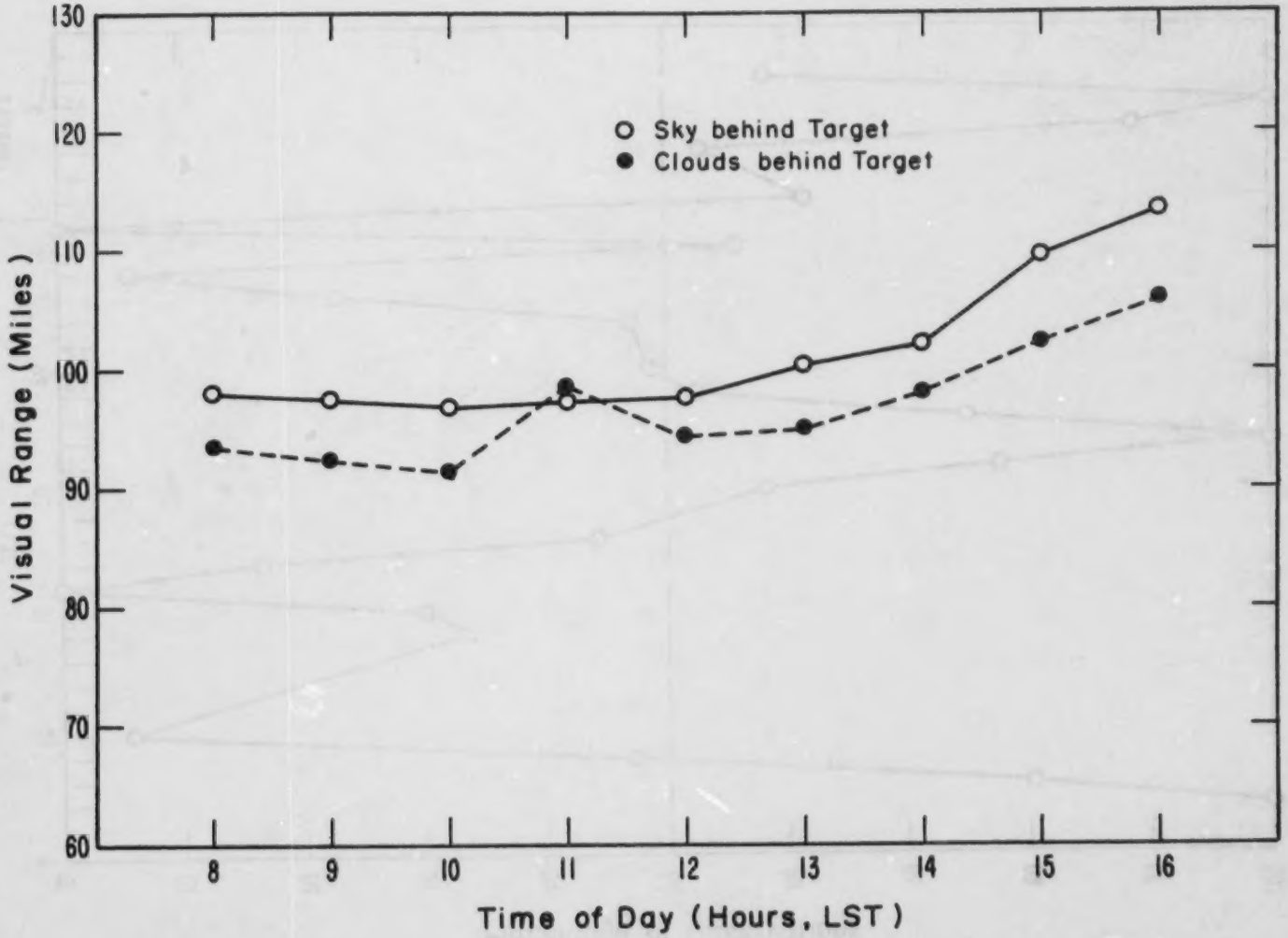


Figure 8. Average hourly visual range for an overall view, Cedar Mountain, Utah.

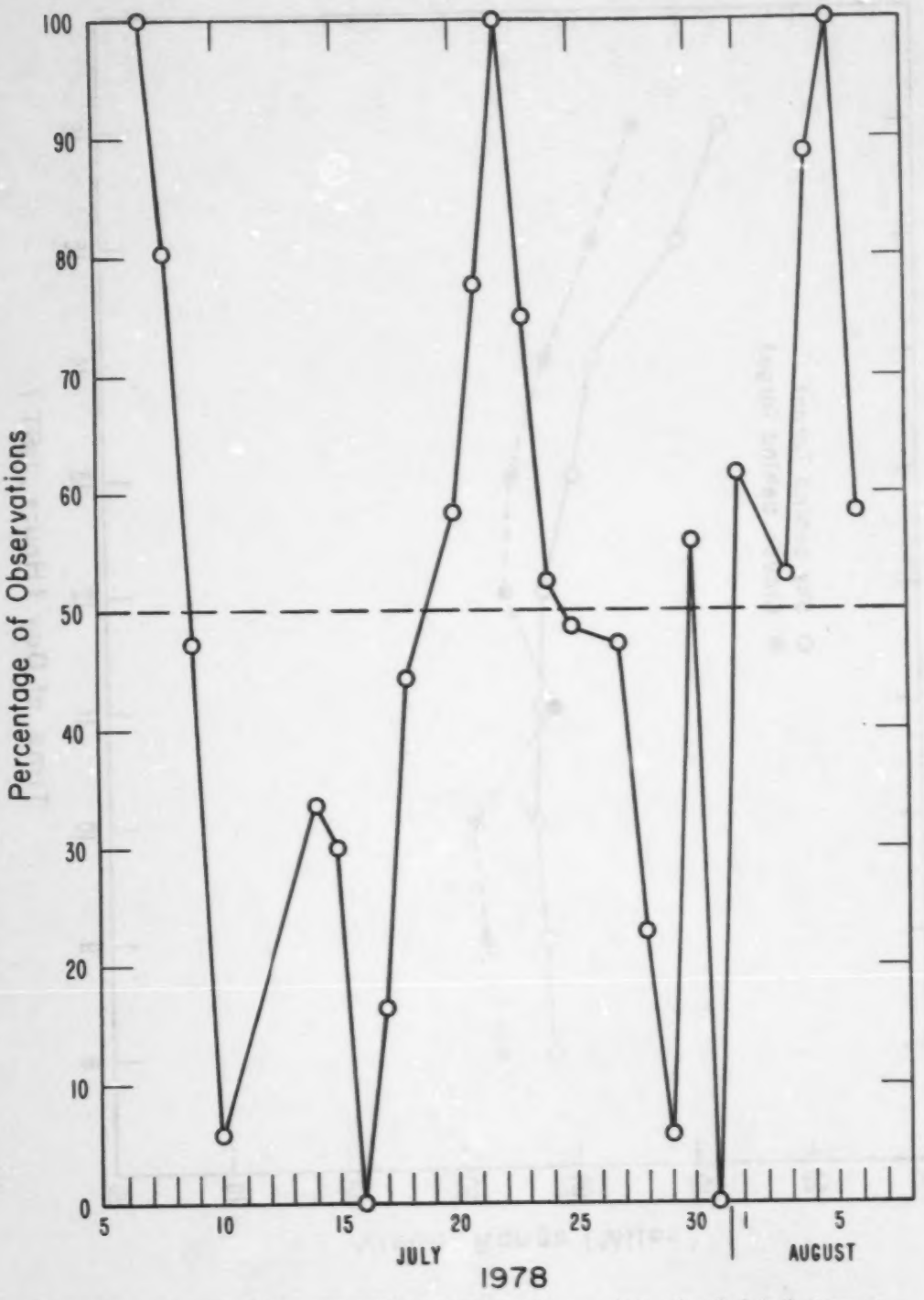


Figure 9. Percentage of daily observations with sky behind target.

had clouds behind the target. S and C are used to denote more than 50 percent SBT and CBT during the day.

### 3.3 Average Daily Values of Telephotometric Visual Range

The average daily values of visual range, number of observations and standard deviation for four views and an overall view are tabulated in Tables 4 through 9. The data are plotted in Figs. 10 through 14. The day with greatest visual range average was July 14, with a daily average of 119.9 miles for all four views, with 34 percent SBT; the NT had the highest daily value of 140.0 miles; the WT had the lowest daily value of 96.1 miles. The lowest daily average visual range was July 29, with 3 percent SBT and an average of 81.1 miles for all four views; the ET had the highest average of 86.6 miles; the WT had the lowest average value of 76.0 miles.

### 3.4 Average Values of Telephotometric Visual Range for Observation Period

Tables 6, 9 (at end of the tables) and 10 have average values of visual range for the four views (SBT and CBT), for overall view (SBT and CBT), and for the total overall view for the observational period. The NT and ET have essentially the same visual range, SBT and CBT. The WT has the lowest visual range. The overall view, SBT and CBT, and the total overall view are essentially the same average view.

### 3.5 Effect of Cloud Cover between Observer and Target on Visual Range

When visual range observations were taken an estimate of the cloud cover in the sky along the line of sight between the observer and the target was recorded. These data have been categorized as SBT or CBT with sky conditions clear (CLR), scattered clouds (SCT), broken clouds (BKN) or overcast (OVC). CLR is less than .1 cloud cover, SCT .1 to less than .6 cloud cover, BKN .6 to .9 cloud cover inclusive and OVC more than .9 cloud cover. If the particle size and concentration remain the same, there should be an increase in the average visual range with increasing cloud cover that shadows the particulates within the line of sight, with less direct sunlight being scattered from the intervening particles. The data are shown in Table 11. For SBT conditions more of the targets exhibit a decreased visual range with increasing cloud cover between the observer and the target in going from the clear to the scattered cloud cover category. An explanation for this inverse relationship is that probably increasing sky cover indicates increasing relative humidity, which by absorption physically increases the size of the particles in the line of sight, resulting in decreased visual range. The visual ranges of the Henry Mountains and the Abajo Mountains exhibit less of this effect, possibly because there were fewer clouds and lower relative humidity between the observer and these targets 72 and 110 miles distant. The Henry Mountains and Abajo Mountains are isolated mountains, located

Table 4. Data for views from Cedar Mountain, Emery County, Utah, with sky behind target.

| TARGET | | NORTH | EAST | SOUTH | WEST | OVERALL |
|---|---|---|---|---|---|---|
| DAY JUL. 1978 | | | | | | |
| 7 | N | 9 | 9 | 9 | 9 | 36 |
| | $V_r$ av. | 107.2 | 109.9 | 101.9 | 94.7 | 102.4 |
| | σ | 8.7 | 14.0 | 5.2 | 17.1 | 13.0 |
| 8 | N | 3 | 9 | 8 | 9 | 29 |
| | $V_r$ av. | 112.5 | 96.2 | 86.9 | 83.0 | 91.3 |
| | σ | 3.4 | 10.1 | 7.2 | 16.3 | 13.5 |
| 9 | N | 4 | 0 | 4 | 9 | 17 |
| | $V_r$ av. | 103.9 | — | 93.1 | 91.5 | 95.2 |
| | σ | 3.6 | — | 9.4 | 16.9 | 12.9 |
| 10 | N | 0 | 1 | 0 | 2 | 3 |
| | $V_r$ av. | — | 118.9 | — | 72.8 | 88.2 |
| | σ | — | — | — | 12.3 | 29.2 |
| 14 | N | 1 | 9 | 1 | 2 | 13 |
| | $V_r$ av. | 149.8 | 126.5 | 107.7 | 95.9 | 121.8 |
| | σ | — | 5.6 | — | 1.2 | 13.5 |
| 15 | N | 0 | 0 | 0 | 1 | 1 |
| | $V_r$ av. | — | — | — | 59.3 | 59.3 |
| | σ | — | — | — | — | — |
| 16 | N | 0 | 0 | 0 | 0 | 0 |
| | $V_r$ av. | — | — | — | — | — |
| | σ | — | — | — | — | — |
| 17 | N | 3 | 1 | 0 | 1 | 5 |
| | $V_r$ av. | 79.5 | 118.5 | — | 56.4 | 82.7 |
| | σ | 4.8 | — | — | — | 10.8 |
| 18 | N | 3 | 8 | 4 | 1 | 16 |
| | $V_r$ av. | 106.0 | 115.0 | 92.7 | 68.5 | 104.8 |
| | σ | 0.6 | 22.6 | 8.4 | — | 21.9 |

Note: N = Number of hourly observations.
σ = Standard deviation.
$V_r$ av. = Average visibility (miles).

Table 5. Data for views from Cedar Mountain, Emery County, Utah, with sky behind target.

| TARGET | | NORTH | EAST | SOUTH | WEST | OVERALL |
|---|---|---|---|---|---|---|
| DAY JUL. 1978 | | | | | | |
| 20 | N | 2 | 0 | 9 | 9 | 20 |
| | $V_r$ av. | 108.9 | — | 108.6 | 99.3 | 104.4 |
| | σ | 1.6 | — | 14.8 | 14.2 | 13.1 |
| 21 | N | 1 | 9 | 9 | 9 | 28 |
| | $V_r$ av. | 91.4 | 101.4 | 97.7 | 91.1 | 98.0 |
| | σ | — | 7.7 | 16.1 | 22.5 | 16.3 |
| 22 | N | 9 | 9 | 9 | 9 | 36 |
| | $V_r$ av. | 112.5 | 113.4 | 102.8 | 102.2 | 107.6 |
| | σ | 4.0 | 4.9 | 8.1 | 17.1 | 10.6 |
| 23 | N | 6 | 9 | 7 | 4 | 26 |
| | $V_r$ av. | 117.6 | 120.8 | 103.6 | 94.4 | 111.4 |
| | σ | 4.8 | 5.7 | 6.2 | 3.0 | 23.3 |
| 24 | N | 4 | 5 | 5 | 4 | 18 |
| | $V_r$ av. | 107.8 | 109.2 | 96.7 | 81.7 | 99.3 |
| | σ | 6.0 | 3.6 | 4.4 | 2.6 | 11.8 |
| 25 | N | 3 | 4 | 6 | 4 | 17 |
| | $V_r$ av. | 120.6 | 108.3 | 102.6 | 83.2 | 102.6 |
| | σ | 10.1 | 2.4 | 5.4 | 0.6 | 12.7 |
| 27 | N | 6 | 9 | 0 | 0 | 15 |
| | $V_r$ av. | 86.7 | 100.3 | — | — | 94.9 |
| | σ | 5.0 | 14.5 | — | — | 8.7 |
| 28 | N | 1 | 3 | 2 | 2 | 8 |
| | $V_r$ av. | 84.2 | 96.4 | 92.2 | 55.2 | 83.5 |
| | σ | — | 4.9 | 2.1 | 5.5 | 7.0 |
| 29 | N | 0 | 0 | 1 | 0 | 1 |
| | $V_r$ av. | — | — | 73.0 | — | 73.0 |
| | σ | — | — | — | — | — |

Note: N = Number of hourly observations
σ = Standard deviation.
$V_r$ av. = Average visibility (miles).

Table 6. Data for views from Cedar Mountain, Emery County, Utah, sky behind target.

| TARGET | | NORTH | EAST | SOUTH | WEST | OVERALL |
|---|---|---|---|---|---|---|
| DAY JUL. 1978 | | | | | | |
| 30 | N | 4 | 5 | 7 | 4 | 20 |
| | $V_r$ av. | 104.2 | 107.9 | 95.2 | 73.8 | 95.9 |
| | σ | 4.0 | 9.0 | 7.0 | 7.0 | 15.1 |
| 31 | N | 0 | 0 | 0 | 0 | 0 |
| | $V_r$ av. | — | — | — | — | — |
| | σ | — | — | — | — | — |
| AUG 1 | N | 2 | 8 | 6 | 5 | 21 |
| | $V_r$ av. | 94.7 | 93.5 | 84.1 | 69.9 | 85.3 |
| | σ | 5.0 | 12.6 | 6.6 | 4.3 | 12.6 |
| 3 | N | 4 | 4 | 5 | 2 | 15 |
| | $V_r$ av. | 111.3 | 100.4 | 98.5 | 76.3 | 99.5 |
| | σ | 4.4 | 3.1 | 2.6 | 0.4 | 10.2 |
| 4 | N | 7 | 7 | 9 | 9 | 32 |
| | $V_r$ av. | 110.3 | 105.7 | 107.9 | 96.7 | 104.3 |
| | σ | 9.7 | 4.3 | 14.1 | 14.3 | 12.4 |
| 5 | N | 9 | 9 | 9 | 9 | 36 |
| | $V_r$ av. | 106.2 | 106.3 | 91.7 | 96.2 | 99.1 |
| | σ | 11.8 | 14.0 | 6.5 | 12.9 | 12.4 |
| 6 | N | 4 | 5 | 7 | 5 | 21 |
| | $V_r$ av. | 95.1 | 84.7 | 85.9 | 74.5 | 84.7 |
| | σ | 5.3 | 6.3 | 7.6 | 4.0 | 8.2 |
| | N | | | | | |
| | $V_r$ av. | | | | | |
| | σ | | | | | |
| ALL DAYS | N | 85 | 123 | 117 | 109 | |
| | $V_r$ av. | 105.9 | 106.9 | 97.3 | 88.4 | |
| | σ | 6.4 | 10.1 | 8.7 | 13.2 | |

Note: N = Number of hourly observations.
σ = Standard deviation.
$V_r$ av. = Average visibility (miles).

Table 7. Data for views from Cedar Mountain, Emery County, Utah, with clouds behind target.

| TARGET | | NORTH | EAST | SOUTH | WEST | OVERALL |
|---|---|---|---|---|---|---|
| DAY JUL. 1978 | | | | | | |
| 7 | N | 0 | 0 | 0 | 0 | 0 |
| | $V_r$ av. | — | — | — | — | — |
| | σ | — | — | — | — | — |
| 8 | N | 6 | 0 | 1 | 0 | 7 |
| | $V_r$ av. | 105.5 | — | 81.7 | — | 98.3 |
| | σ | 6.8 | — | — | — | 8.6 |
| 9 | N | 5 | 9 | 5 | 0 | 19 |
| | $V_r$ av. | 116.0 | 113.9 | 114.4 | — | 114.0 |
| | σ | 4.6 | 6.9 | 5.1 | — | 6.2 |
| 10 | N | 8 | 8 | 9 | 7 | 32 |
| | $V_r$ av. | 114.4 | 107.3 | 81.6 | 95.2 | 98.9 |
| | σ | 27.9 | 14.1 | 26.6 | 15.8 | 20.5 |
| 14 | N | 8 | 0 | 8 | 7 | 23 |
| | $V_r$ av. | 139.4 | — | 119.7 | 96.1 | 118.8 |
| | σ | 12.0 | — | 9.8 | 17.7 | 21.1 |
| 15 | N | 8 | 8 | 8 | 7 | 31 |
| | $V_r$ av. | 121.2 | 115.0 | 94.1 | 96.3 | 103.9 |
| | σ | 19.8 | 17.2 | 25.5 | 29.1 | 24.6 |
| 16 | N | 6 | 6 | 4 | 5 | 21 |
| | $V_r$ av. | 103.3 | 101.8 | 93.0 | 98.6 | 96.5 |
| | σ | 15.1 | 17.3 | 19.2 | 21.6 | 20.5 |
| 17 | N | 5 | 7 | 7 | 5 | 24 |
| | $V_r$ av. | 115.0 | 107.0 | 77.1 | 82.4 | 94.8 |
| | σ | 34.2 | 22.4 | 9.5 | 30.3 | 26.9 |
| 18 | N | 5 | 1 | 5 | 8 | 19 |
| | $V_r$ av. | 94.9 | 81.3 | 73.6 | 78.6 | 81.7 |
| | σ | 9.0 | — | 14.7 | 8.6 | 15.1 |

Note: N = Number of hourly observations.
σ = Standard deviation.
$V_r$ av. = Average visibility (miles).

Table 8. Data for views from Cedar Mountain, Emery County, Utah, with clouds behind target.

| TARGET | | NORTH | EAST | SOUTH | WEST | OVERALL |
|---|---|---|---|---|---|---|
| DAY JUL. 1978 | | | | | | |
| 20 | N | 7 | 9 | 0 | 0 | 16 |
| | $V_r$ av. | 123.4 | 125.0 | — | — | 124.3 |
| | σ | 10.2 | 12.8 | — | — | 14.4 |
| 21 | N | 8 | 0 | 0 | 0 | 8 |
| | $V_r$ av. | 116.0 | — | — | — | 116.0 |
| | σ | 14.7 | — | — | — | 14.7 |
| 22 | N | 0 | 0 | 0 | 0 | 0 |
| | $V_r$ av. | — | — | — | — | — |
| | σ | — | — | — | — | — |
| 23 | N | 3 | 0 | 2 | 4 | 9 |
| | $V_r$ av. | 124.1 | — | 118.7 | 125.9 | 121.7 |
| | σ | 3.2 | — | 2.2 | 14.1 | 3.5 |
| 24 | N | 5 | 3 | 4 | 5 | 17 |
| | $V_r$ av. | 110.3 | 112.7 | 114.2 | 98.1 | 106.9 |
| | σ | 13.5 | 6.5 | 7.1 | 9.6 | 11.4 |
| 25 | N | 5 | 5 | 3 | 5 | 18 |
| | $V_r$ av. | 89.7 | 89.7 | 102.6 | 93.2 | 92.8 |
| | σ | 11.3 | 12.8 | 5.5 | 8.3 | 15.0 |
| 27 | N | 3 | 0 | 9 | 6 | 18 |
| | $V_r$ av. | 122.4 | — | 98.3 | 64.8 | 91.2 |
| | σ | 30.9 | — | 25.8 | 8.8 | 29.0 |
| 28 | N | 7 | 6 | 6 | 6 | 25 |
| | $V_r$ av. | 81.9 | 93.0 | 99.8 | 74.5 | 87.1 |
| | σ | 13.0 | 10.7 | 15.9 | 10.8 | 18.3 |
| 29 | N | 9 | 9 | 7 | 9 | 34 |
| | $V_r$ av. | 83.8 | 86.6 | 79.3 | 76.0 | 80.7 |
| | σ | 9.1 | 9.4 | 12.9 | 12.7 | 11.2 |

Note: N = Number of hourly observations.
σ = Standard deviation.
$V_r$ av. = Average visibility (miles).

Table 9. Data for views from Cedar Mountain, Emery County, Utah, with clouds behind target

| TARGET | | NORTH | EAST | SOUTH | WEST | OVERALL |
|---|---|---|---|---|---|---|
| DAY JUL. 1978 | | | | | | |
| 30 | N | 5 | 4 | 2 | 5 | 16 |
| | $V_r$ av. | 106.2 | 105.5 | 106.0 | 99.0 | 103.8 |
| | σ | 8.5 | 2.9 | 31.7 | 7.3 | 6.0 |
| 31 | N | 9 | 9 | 9 | 9 | 36 |
| | $V_r$ av. | 97.0 | 100.8 | 87.5 | 85.9 | 92.5 |
| | σ | 25.1 | 15.0 | 11.1 | 13.6 | 17.4 |
| AUG 1 | N | 7 | 1 | 3 | 3 | 14 |
| | $V_r$ av. | 78.9 | 78.6 | 84.1 | 83.5 | 81 |
| | σ | 16.2 | — | 7.1 | 0.7 | 11.1 |
| 3 | N | 4 | 4 | 3 | 6 | 17 |
| | $V_r$ av. | 102.3 | 101.2 | 102.5 | 98.6 | 100.8 |
| | σ | 4.8 | 8.4 | 8.0 | 14.0 | 9.1 |
| 4 | N | 2 | 2 | 0 | 0 | 4 |
| | $V_r$ av. | 103.2 | 127.6 | — | — | 112.9 |
| | σ | 1.2 | 12.3 | — | — | 18.4 |
| 5 | N | 0 | 0 | 0 | 0 | 0 |
| | $V_r$ av. | — | — | — | — | — |
| | σ | — | — | — | — | — |
| 6 | N | 5 | 4 | 2 | 4 | 15 |
| | $V_r$ av. | 62.7 | 83.6 | 103.3 | 86.0 | 79.9 |
| | σ | 10.2 | 6.8 | 22.4 | 11.3 | 18.0 |
| | N | | | | | |
| | $V_r$ av. | | | | | |
| | σ | | | | | |
| ALL DAYS | N | 130 | 95 | 97 | 101 | |
| | $V_r$ av. | 104.8 | 104.2 | 94.7 | 88.9 | |
| | σ | 15.3 | 12.3 | 15.9 | 14.5 | |

Note: N = Number of hourly observations
σ = Standard deviation.
$V_r$ av. = Average visibility (miles).

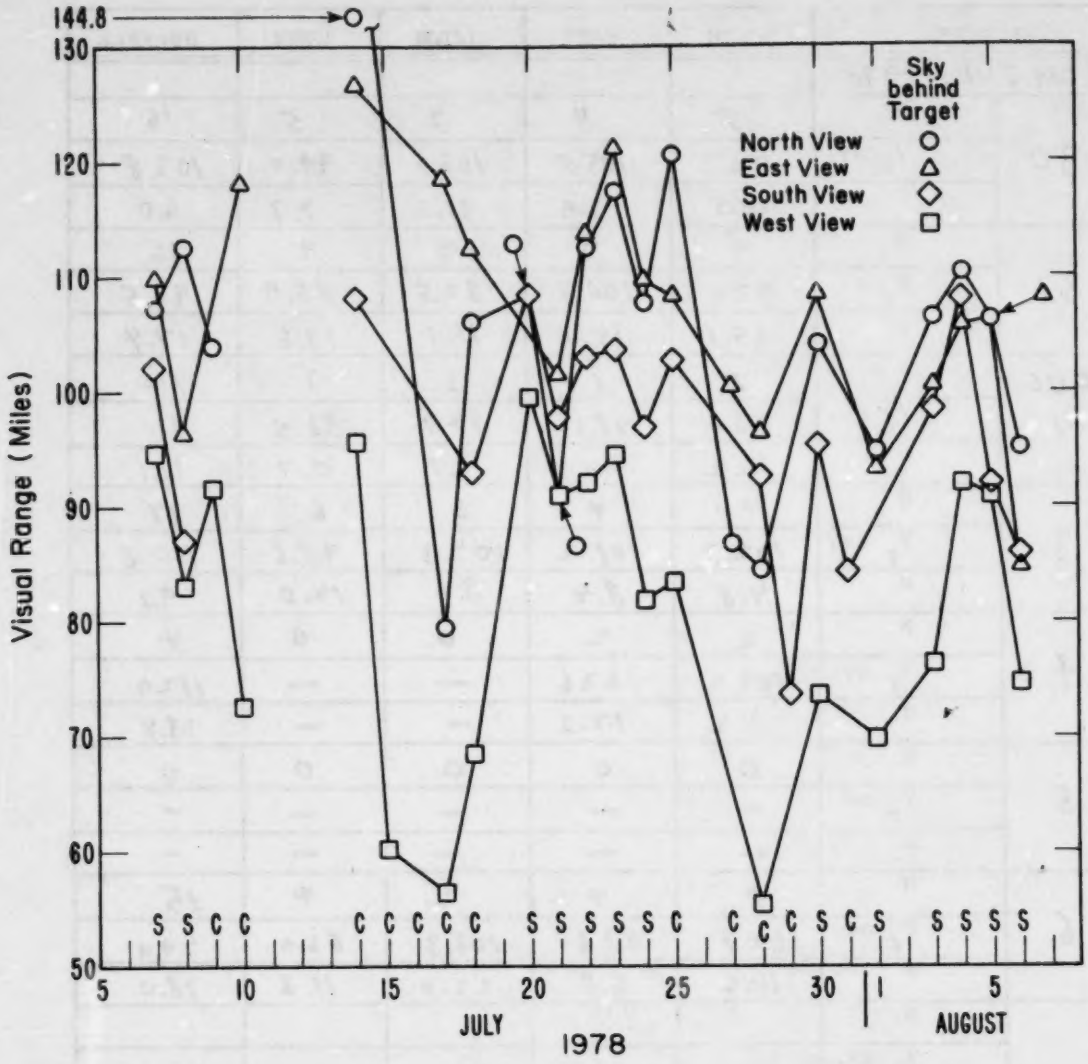


Figure 10. Average daily visual range for four views, Cedar Mountain, Utah, with sky behind target. S, more than 50 percent of observations have sky behind target, C, less than 50 percent.

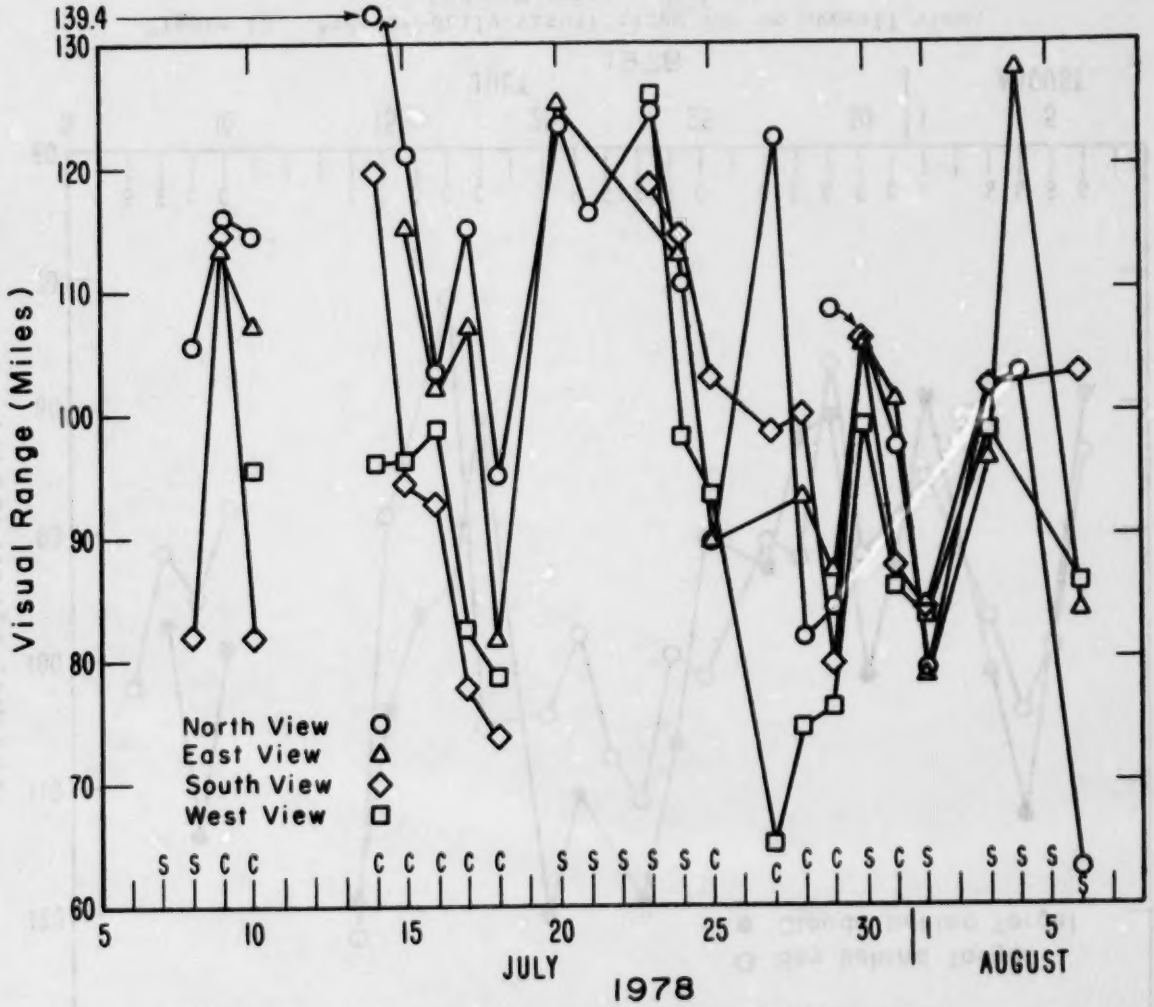


Figure 11. Average daily visual range for four views, Cedar Mountain, Utah, clouds behind target.

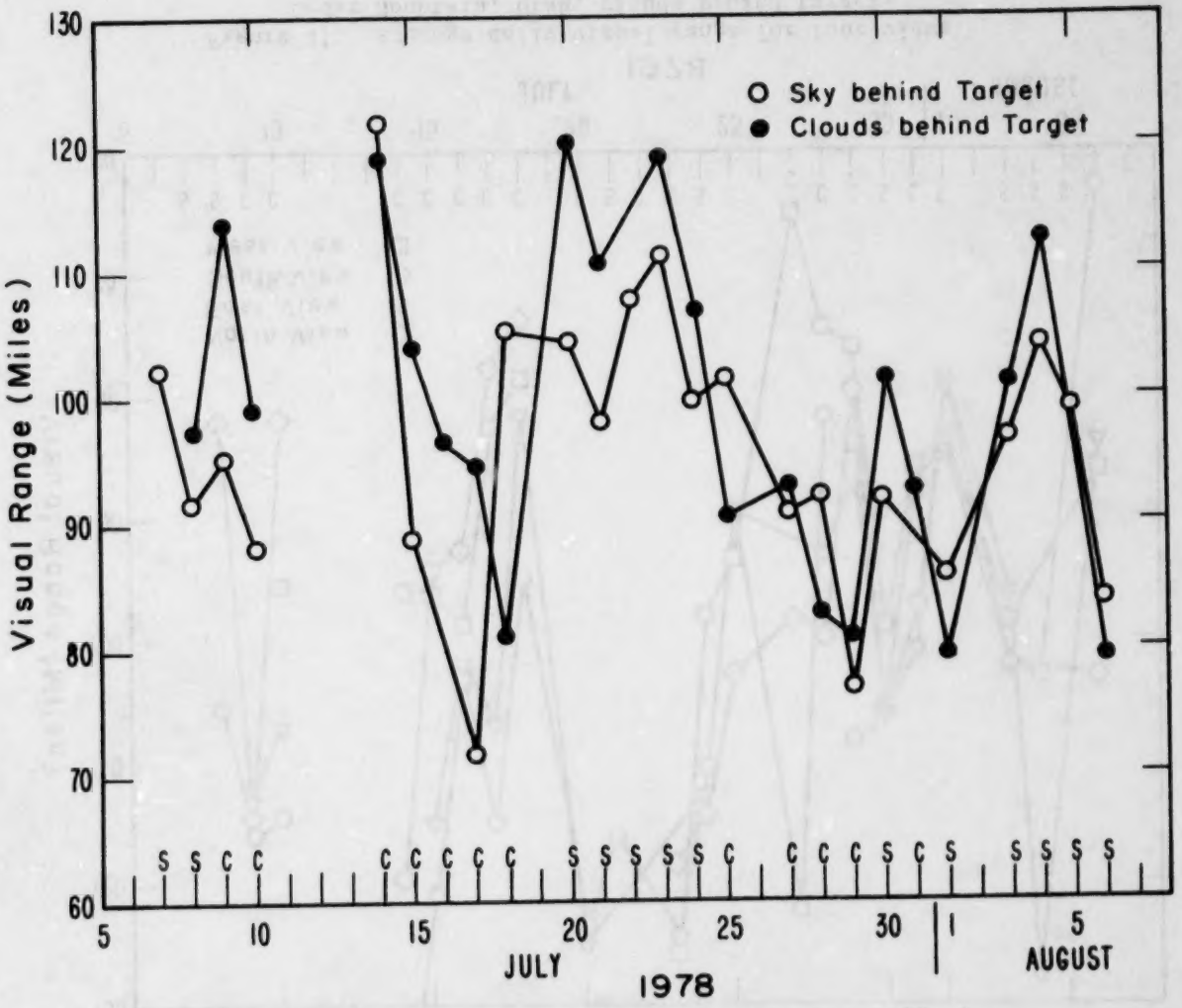


Figure 12. Average daily visual range for an overall view, Cedar Mountain, Utah.

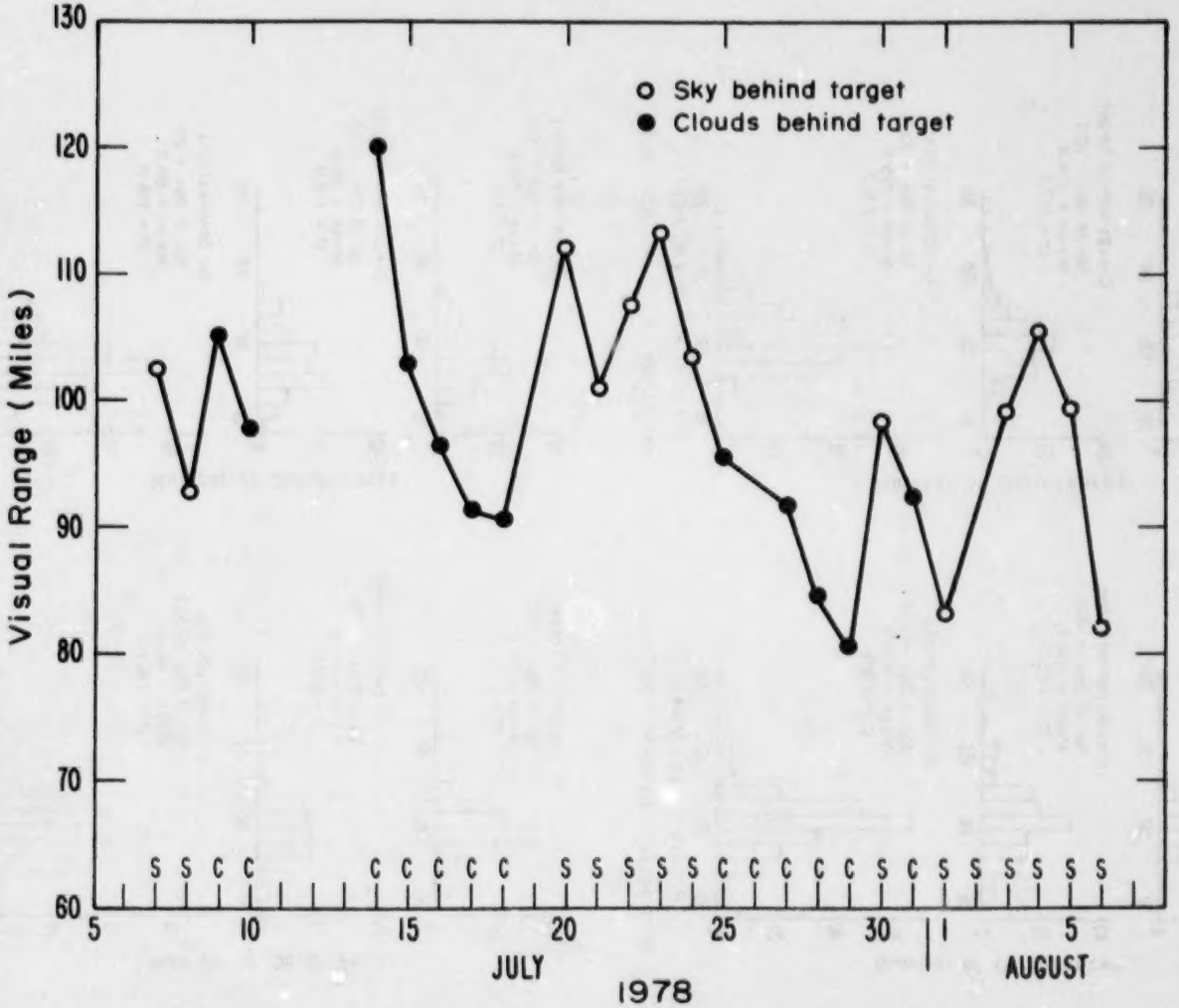


Figure 13. Average daily visual range for an overall view, Cedar Mountain, Utah.

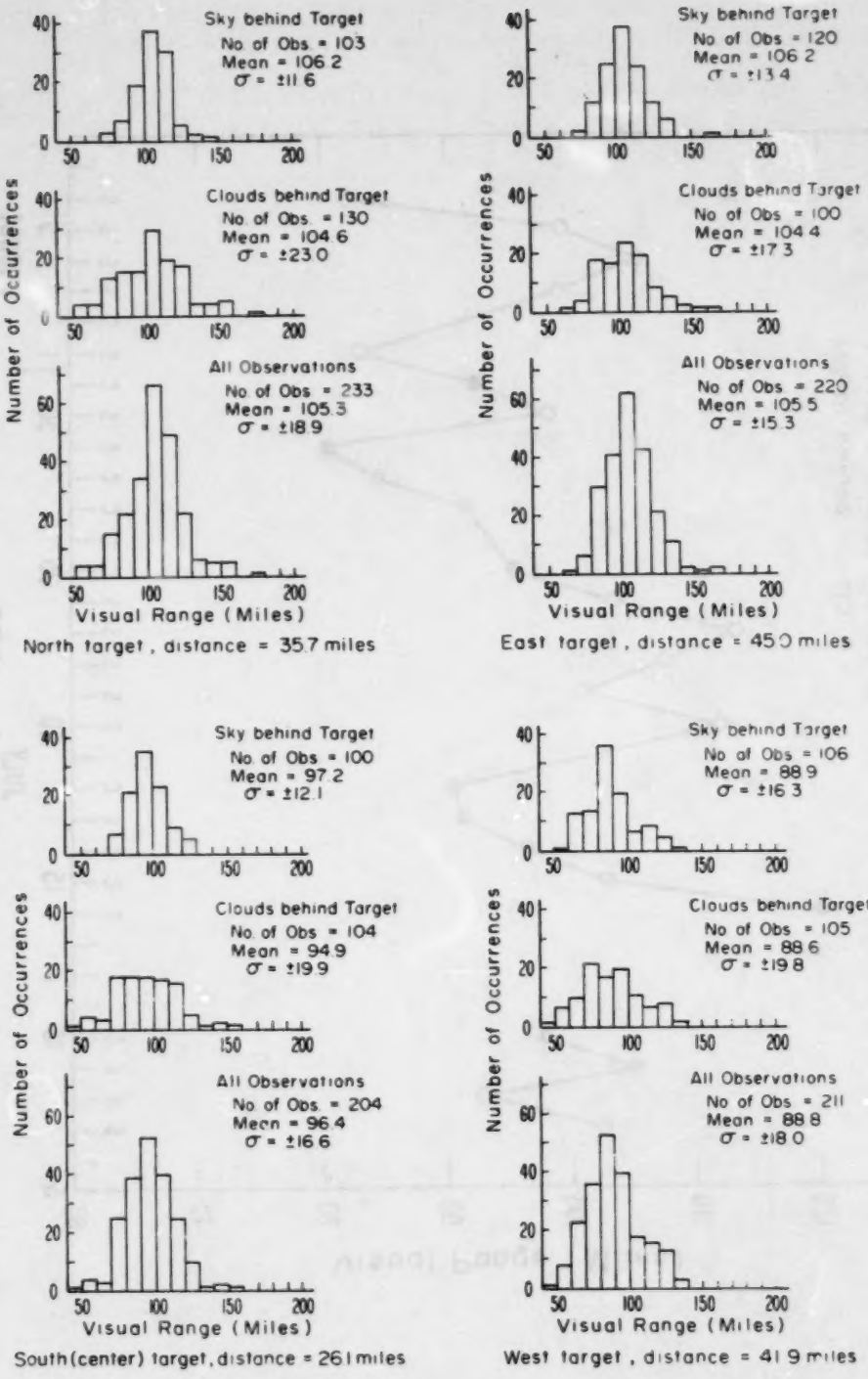
Sky behind Target
No of Obs = 103
Mean = 106 2
σ = ±11 6
Clouds behind Target
No of Obs = 130
Mean = 104 6
σ = ±23 0
All Observations
No of Obs = 233
Mean = 105 3
σ = ±18 9
Number of Occurrences
Visual Range (Miles)
North target, distance = 35 7 miles
Sky behind Target
No of Obs = 120
Mean = 106 2
σ = ±13 4
Clouds behind Target
No of Obs = 100
Mean = 104 4
σ = ±17 3
All Observations
No of Obs = 220
Mean = 105 5
σ = ±15 3
Visual Range (Miles)
East target, distance = 45 0 miles
Sky behind Target
No of Obs = 100
Mean = 97 2
σ = ±12 1
Clouds behind Target
No of Obs = 104
Mean = 94 9
σ = ±19 9
All Observations
No of Obs = 204
Mean = 96 4
σ = ±16 6
Number of Occurrences
Visual Range (Miles)
South (center) target, distance = 26 1 miles
Sky behind Target
No of Obs = 106
Mean = 88 9
σ = ±16 3
Clouds behind Target
No of Obs = 105
Mean = 88 6
σ = ±19 8
All Observations
No of Obs = 211
Mean = 88 8
σ = ±18 0
Visual Range (Miles)
West target, distance = 41 9 miles

**Figure 14. Visual range of four views, Cedar Mountain, Utah.**

Table 10. Summary of data for views from Cedar Mountain, Emery County, Utah, for the period of July 7 through August 6 1978.

| SUMMARY | | | | SBT | CBT | OVERALL |
|---|---|---|---|---|---|---|
| | | | | | | |
| | N | | | 422 | 446 | 868 |
| | $V_r$ av. | | | 99.0 | 96.8 | 97.0 |
| | $\sigma$ | | | 15.7 | 21.3 | 18.8 |

Note. N = Number of hourly observations
$\sigma$ = Standard deviation.
$V_r$ av. = Average visibility (miles).

in dry desert terrain, compared with the four standard local targets that are surrounded by extensive mountain ranges, except toward the south. There are not enough data for BKN and OVC conditions to formulate any further conclusions.

For CBT conditions, SCT, BKN, and OVC cloud covers resulted in lower average visual range for the four views, as cloud cover increased (and presumably relative humidity also increased), the visual range decreased. Only the ET visual range with OVC sky cover approached the visual range with CLR sky cover. The Henry Mountains and Abajo Mountains visual ranges decreased with SCT cloud cover, average visual range was the same for OVC and CLR conditions.

Of the 11 values of visual range above 150 miles that were measured during the observational period, all were CBT; four were SCT, two BKN, and five OVC. Three of the five OVC had targets under cloud shadows, and two of these had the longest measured visual range at 221 miles (July 15, ET, 1200 MST) and 305 miles (July 17, WT, 1600 MST). Bright clouds behind a target and a shadowed target appear to be more important as a cause of increased contrast between the target and horizon sky (and thus increased visual range) than is the shadowing of the intervening particulates by clouds between the observer and the target.

Late evening measurements of visual range will exceed 150 miles, especially the ST when the target and the light path between the observer and target are in the shadow of the Wasatch Plateau just before sundown, while the horizon sky beyond the ST is still sunlit. The visual range of the ST target reached 245 miles under this condition; the WT and NT reached 167 and 161 miles, respectively. The ET reached its maximum visual range at 155 miles, about 30 minutes earlier than the other targets; apparently the eastern horizon sky became less bright more rapidly than the target did as the sun sank lower in the west, lowering

Table 11. Sky condition behind target and the sky condition between the observer and the target classified by number of observations, for the four standard views, the Henry Mountains, and the Abajo Mountains.

| TARGET | | NORTH | EAST | SOUTH | WEST | HENRY/ABAJO |
|---|---|---|---|---|---|---|
| SKY CONDITIONS | | | | | | |
| SBT CLR | N | 70 | 94 | 86 | 94 | 95 / 105 |
| | $V_r$ av. | 104.5 | 107.5 | 98.0 | 89.3 | 112.4 / 131.9 |
| | σ | 9.6 | 12.5 | 11.9 | 15.7 | 11.4 / 11.0 |
| SBT SCT | N | 16 | 26 | 14 | 12 | 14 / 21 |
| | $V_r$ av. | 89 | 104.8 | 92.2 | 85.7 | 112.3 / 127.7 |
| | σ | 13.3 | 19.5 | 12.9 | 21.6 | 13.1 / 10.7 |
| SBT BKN | N | — | 2 | 2 | 1 | 2 / 1 |
| | $V_r$ av. | — | 126.6 | 94.0 | 123.3 | 101.9 / 139.4 |
| | σ | — | — | — | — | — / — |
| SBT OVC | N | — | — | — | — | — / — |
| | $V_r$ av. | — | — | — | — | — / — |
| | σ | — | — | — | — | — / — |
| CBT CLR | N | 37 | 17 | 14 | 13 | 14 / 8 |
| | $V_r$ av. | 106.9 | 117.3 | 106.7 | 102.7 | 120.7 / 143.7 |
| | σ | 13.4 | 9.8 | 13.7 | 18.9 | 14.7 / 10.9 |
| CBT SCT | N | 57 | 47 | 58 | 59 | 58 / 22 |
| | $V_r$ av. | 92.4 | 98.5 | 93.3 | 82.6 | 111.6 / 132.0 |
| | σ | 21.9 | 15.2 | 16.0 | 16.5 | 16.0 / 13.6 |
| CBT BKN | N | 19 | 15 | 18 | 16 | 17 / 14 |
| | $V_r$ av. | 104.9 | 101.8 | 96.4 | 91.0 | 114.1 / 125.2 |
| | σ | 24.6 | 13.2 | 32.4 | 20.0 | 18.5 / 9.4 |
| CBT OVC | N | 18 | 19 | 14 | 17 | 12 / 12 |
| | $V_r$ av. | 100.0 | 113.3 | 79.4 | 93.8 | 120.3 / 143.9 |
| | σ | 31.4 | 34.7 | 25.3 | 22.9 | 18.8 / 15.4 |

Note: N = Number of hourly observations.
σ = Standard deviation.
$V_r$ av. = Average visibility (miles).

the contrast ratio, since during this period the ET face was still in direct sunlight.

### 3.6 Comparison of the Visual Range of Seven Targets During the Observation Period

Figs. 14 and 15 are histograms categorizing the visual range data by SBT, CBT, and overall observations for seven targets. The NT, ET, ST, and WT of Fig. 14 are standard views shown in Figs. 3, 4, 5, and 6. Fig. 15 shows the Henry Mountains, Abajo Mountains, and a special view of the ST.

The $ST_{center}$ target of Fig. 14 is the target shown in Fig. 5. Aircraft reconnaissance of the ST, Block Mountain, a flat topped mesa, shows that there is a point of land on the north side of the mesa pointing toward the observer. During the morning the western cliffs of Block Mountain are in shadow until about local noontime, the eastern cliffs are in shadow after the 1300 MST observation. During the observation period visual range data were taken on the west side during the morning and on the east side during the afternoon. As expected, the shadowed target did increase the contrast between the target and horizon sky, but only in the amount of 2 percent, not enough to make it worthwhile using the shaded side of Block Mountain as the target rather than the center ($S_{center}$) of the point. In future reports only the $S_{center}$ target will be used, and will be designated the south target, ST.

The average visual range toward the Henry Mountains is about 15 miles longer that the visual range toward ST, the visual range toward the Abajo Mountains is about 35 miles longer. Much of the increase can be attributed to looking through upper layers of the atmosphere, which are more free of particulates than the optical path of view of the four local views.

### 3.7 Illuminance of Sky Above Target and Visual Range of Target

It appears subjectively that the southern sky, with no clouds, above Block Mountain, the south target, has lower illuminance when the visual range is low. To test this, a series of measurements of the illuminance of the sky above the horizon was taken, with no portion of Block Mountain in the field of view of the telephotometer. Linear regression curves and the coefficient of correlation of the illuminance of the sky above the horizon and the visual range to the south target were calculated for each set of hourly values. The hourly coefficient of correlation varied: $-.56 < r < +.76$ with $r_{av} = .31$. Clearly there is no useful relationship between the visual range and the sky illuminance measured with a photopic filter.

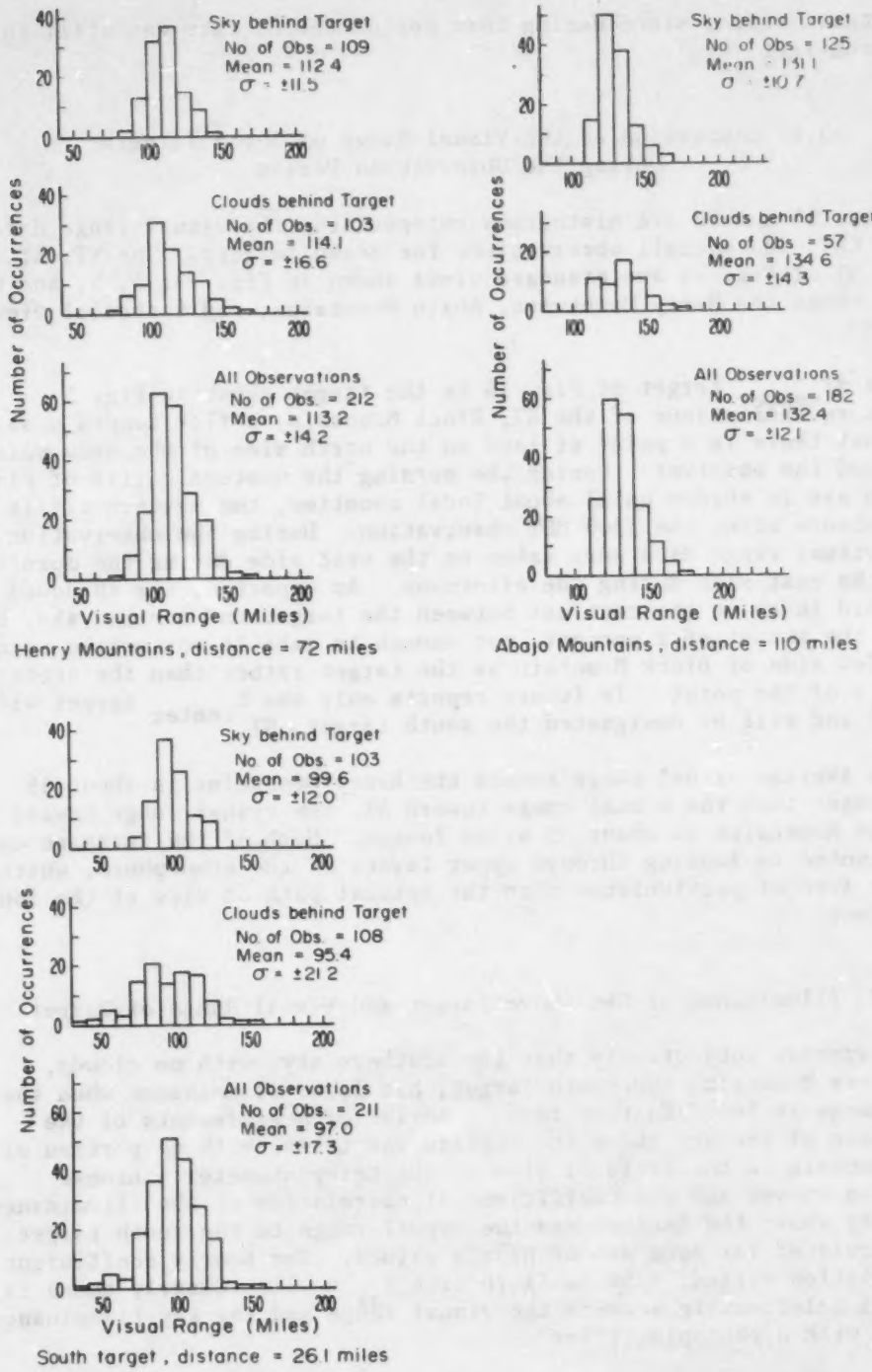


**Figure 15. Visual range of three supplementary views, Cedar Mountain, Utah.**

## 3.8 Comparison of Daily Average Telephotometric and Photographic Visual Range

Fig. 16 compares the telephotometric visual range through a photopic filter, and the photographic visual range as determined by the Martin Marietta Corporation, Denver Division. The telephotometric range shows greater variability of amplitude, and values more than 50 percent greater most of the time. Some reasons for this discrepancy have been investigated. A method of transforming the photographic visual range to "equivalent" concurrent values of telephotometric visual range has been devised. It is proposed that the photographic method be completely replaced with telephotometric measurements in the future. Also, a method of converting previously acquired photographic data to its equivalent telephotometric value is needed.

### 3.8.1 Discussion of Photographic Visual Range

The Martin Marietta Corporation, Denver Division, under NOAA contract No. 03-7-022-35107 furnished a report of photographically derived visual ranges that were concurrent with telephotometrically derived visual ranges.

Hourly photographs of the four targets were taken with an Olympus OM-1 camera equipped with a Schmitt-Cassegrain (Celestron 8) 2000 mm, f10 lens. The film used was Kodak Panatomic X, black and white, ASA 32. A sensitometric calibration of the film was made with a step wedge (21 steps) by exposure that produces a film density (D) versus exposure (actually log E) curve for the film as shown on Fig. 17. From densitometer measurements the target and sky illuminances could be determined. The visual range was calculated by using Eq. 7.

The Martin Marietta Corporation used a straight line to approximate the central portion of the characteristic curve for the film to derive values of the target and sky illuminance. By this method values of D above the inflection point E (at D = 1.2) would be underestimated, values of D below the inflection point would overestimate the value of E (refer to Fig. 17). For a pair of illuminance readings on target and sky the upper curve values of D are associated with sky illuminance, lower values of D with target illuminance. The result is that when the straight line evaluation is made the value of E ($B_h$) is decreased and the lower value of E ($B_b$) is increased from the true characteristic curve values, and the subsequent calculated value of visual range is decreased. This accounts partially for the reason that the photographic method results in lower values of visual range than the telephotometric method when compared in Fig. 16.

There are two other factors noted by Middleton (1952) that affect photographic visual range. First, there is scattered light within a camera. A photographic film is sensitive to light from any direction

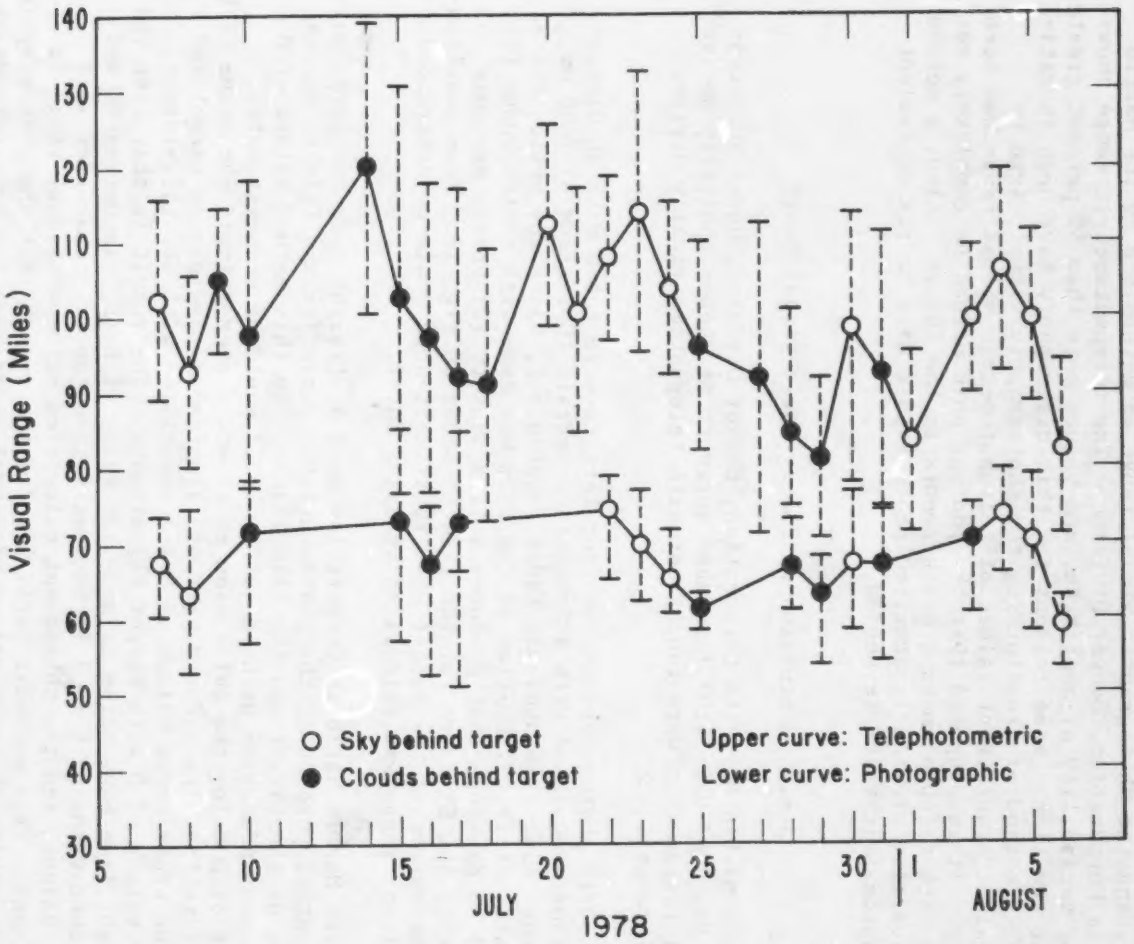


Figure 16. Comparison overall views for telephotometric and photographic visual ranges.

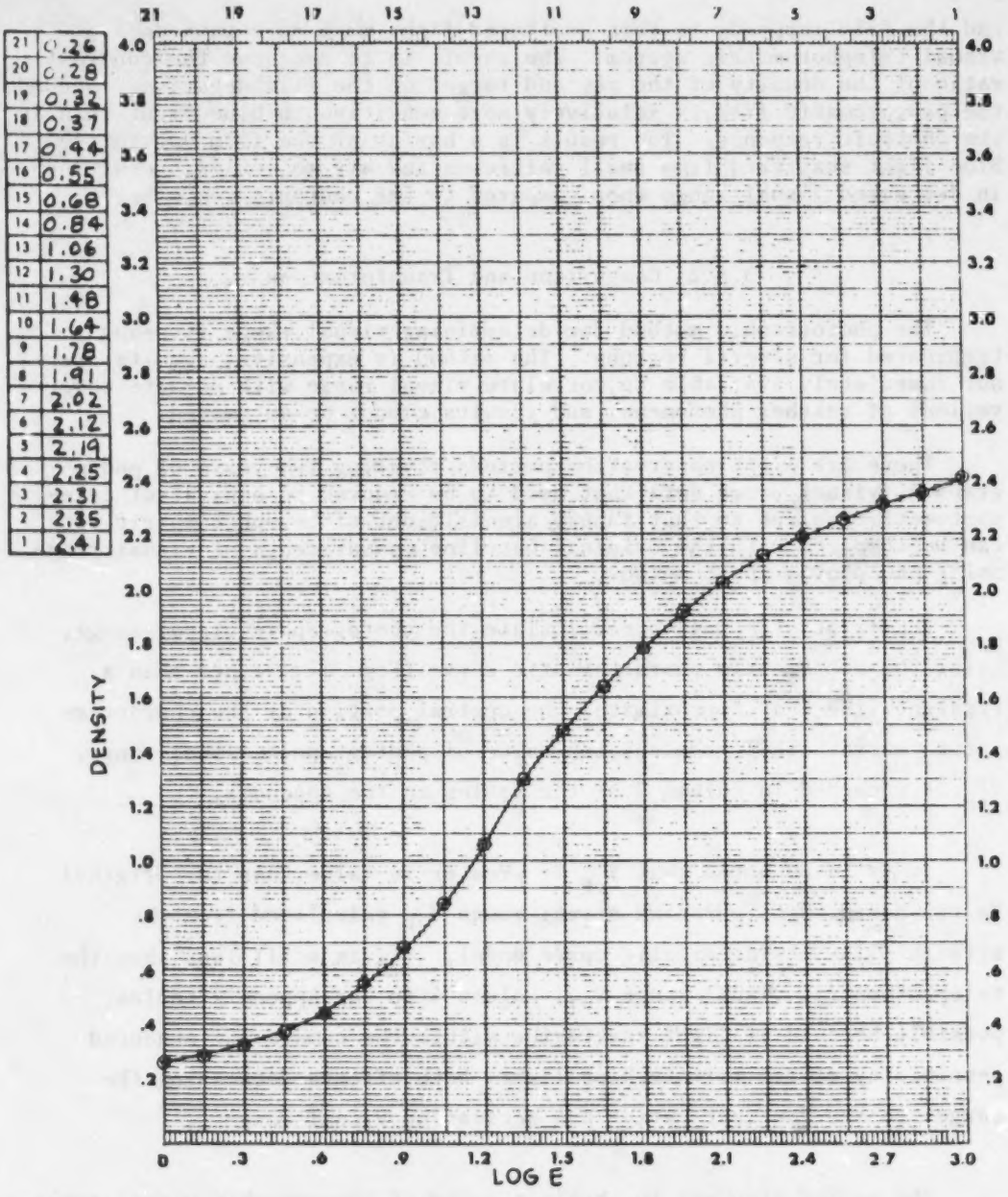


Figure 17. Typical characteristic curve for the film.

and the film responds to this scattered light much more than does a visual telephotometric system. The result is to decrease the contrast ratio of the density of the sky and target on the film negative. Second, the panchromatic film is relatively more sensitive to blue light than is the photopic response. The result is a hazing of the film due to the blue light scattered from small particles and air molecules, resulting in decreased visual range when compared to the photopic response.

### 3.8.2 Comparison and Transformation

The photographic method for determining visual range is being terminated for several reasons. The method is expensive, results are not immediately available to correlate visual range with on-site observations of weather phenomena, and results cannot be automated.

There are eight observation periods covering two years of photographic visual range data that need to be reduced to equivalent telephotometric values so that future acquisitions of telephotometric data can be compared with the original baseline measurements of visual range using the photographic method.

The first step was to recalculate the photographic visual range, using the actual film characteristic curve (Fig. 17) rather than a straight line that approximates the central portion of the characteristic curve. This recalculated value of photographic visual range, $V'_{rP}$ is recorded in column 7 of the tables in the Appendix.

It is to be noted that $V'_{rP}$ is greater in value than the original Martin Marietta Corporation visual range $V_{rP}$ calculated from the straight-line characteristic curve model. $V'_{rP}$ is still less than the telephotometric visual range $V_{rT}$, column 4 in the Appendix tables, possibly because of light scattering within the camera and enhanced sensitivity of the film to blue light, both effects decreasing the target-to-sky contrast ratio--and decreasing visual range.

The second step was to obtain a value of photographic visual range ($V''_{rP}$) corrected to the telephotometric visual range ($V_{rT}$). We used a linear relationship $V_{rT} = b + mV'_{rP}$ from the average of all values of $V_{rT}$ and $V'_{rP}$, to determine b and m, and then calculated values of $V''_{rP}$ equivalent in value to $V_{rT}$ from the equation $V''_{rP} = b + mV'_{rP}$. It was

found that such a model was not satisfactory, so concurrent tabular values of $V'_{rP}$ and $V_{rT}$ for hourly values of NT, ET, ST and WT (both SBT and CBT) were used to determine 72 sets of values of b and m. When hourly values of b and m were graphed for specific target and cloud conditions b and m exhibited a second-degree relationship to time. A second-degree equation was fitted to actual values of b and m. From the smoothed curves were derived 72 values of b and m that were used to convert $V'_{rP}$ to $V''_{rP}$ values for comparison with values of $V_{rT}$. Tables 12 and 13 list the pairs of $V'_{rP}$ and $V_{rT}$ used to derive values of b and m, and the values of b and m derived from the second-degree equation relating b and m and the hour.

Tables 14, 15, 16 and 17 tabulate the 72 values by hour, target, SBT and CBT, the number of observations N, average visual range $V_r$av, standard deviation $\sigma$ for $V_{rT}$ and $V''_{rP}$, and the correlation, r, between $V_{rT}$ and $V''_{rP}$. These tables show that even an occasional low value of r has little effect on the paired values of $V_{rT}$ and $V''_{rP}$ whose average visual ranges agree within a few percent.

## 4. CONCLUSION

The photographic method of measuring visual range gave an overall average of 67.8 miles, SBT, and 68.1 miles, CBT, during July 1978, compared with 68.7 miles, SBT, and 66.7 miles, CBT, during July 1977. The telephotometric method gave a visual range of 99.0 miles, SBT, and and 96.8 miles, CBT. The telephotometric visual ranges are about 50 percent longer than the photographic visual ranges. Subjective visual observations of the Henry Mountains and Abajo Mountains when these targets were barely visible gave telephotometric visual ranges equal, or almost so, to the distance between the observer and the target as calculated by using 0.02 for the liminal contrast ratio in Eq. 7.

After correction of visual range calculations, the photographic values are about 20 percent less than the telephotometric values of visual range. A system of linear corrections of the photographic visual range was devised so that photographic values can be converted to correspond to telephotometric values. Converted values of photographic visual ranges have a smaller standard deviation than that of the concurrent telephotometric values, indicating that extremely high

Table 12. Hourly values of b and m for calculating the linear regression model values of photographic visual range $V''_{rP}$ for four views from the corrected photographic visual range $V'_{rP}$ for sky behind target. $V''_{rP} = b + m(V'_{rP})$.

| TARGET | | NORTH | EAST | SOUTH | WEST | |
|---|---|---|---|---|---|---|
| HOUR | SBT | | | | | |
| 8 | N | 20 | 17 | 17 | 18 | |
| | b | -14.66 | 37.85 | 22.64 | 19.21 | |
| | m | 1.36 | .70 | .85 | .79 | |
| 9 | N | 16 | 16 | 17 | 17 | |
| | b | 6.96 | 40.43 | 25.72 | 27.46 | |
| | m | 1.10 | .68 | .85 | .68 | |
| 10 | N | 17 | 16 | 15 | 14 | |
| | b | 22.60 | 40.42 | 29.06 | 34.67 | |
| | m | .91 | .69 | .85 | .60 | |
| 11 | N | 10 | 17 | 18 | 14 | |
| | b | 32.27 | 37.82 | 32.67 | 40.85 | |
| | m | .79 | .72 | .83 | .54 | |
| 12 | N | 7 | 14 | 15 | 9 | |
| | b | 35.98 | 32.64 | 36.55 | 45.98 | |
| | m | .75 | .78 | .80 | .50 | |
| 13 | N | 5 | 11 | 9 | 8 | |
| | b | 33.72 | 24.87 | 40.69 | 49.98 | |
| | m | .78 | .86 | .76 | .49 | |
| 14 | N | 3 | 10 | 10 | 9 | |
| | b | 25.48 | 14.52 | 45.10 | 52.14 | |
| | m | .89 | .97 | .72 | .50 | |
| 15 | N | 4 | 11 | 9 | 8 | |
| | b | 11.28 | 1.58 | 49.77 | 55.16 | |
| | m | 1.06 | 1.10 | .66 | .54 | |
| 16 | N | 6 | 9 | 8 | 8 | |
| | b | -8.89 | -13.94 | 54.71 | 56.14 | |
| | m | 1.31 | 1.26 | .59 | .60 | |

Table 13. Hourly values of b and m for calculating the linear regression model of photographic visual range $V''_{rP}$ for four views from the corrected photographic visual range $V'_{rP}$ for clouds behind target. $V''_{rP} = b + m(V'_{rP})$.

| TARGET | | NORTH | EAST | SOUTH | WEST | |
|---|---|---|---|---|---|---|
| HOUR | CBT | | | | | |
| 8 | N | 2 | 6 | 5 | 4 | |
| | b | -44.08 | -11.22 | 15.57 | 22.18 | |
| | m | 1.74 | 1.17 | 1.01 | .58 | |
| 9 | N | 8 | 8 | 7 | 7 | |
| | b | -30.51 | -3.47 | 4.75 | 25.31 | |
| | m | 1.46 | 1.11 | 1.15 | .63 | |
| 10 | N | 8 | 9 | 10 | 11 | |
| | b | -19.39 | 2.41 | -3.46 | 24.94 | |
| | m | 1.34 | 1.07 | 1.26 | .70 | |
| 11 | N | 15 | 9 | 7 | 11 | |
| | b | -10.98 | 6.41 | -9.04 | 21.08 | |
| | m | 1.26 | 1.05 | 1.34 | .79 | |
| 12 | N | 18 | 11 | 9 | 13 | |
| | b | -5.28 | 8.53 | -12.00 | 13.71 | |
| | m | 1.22 | 1.05 | 1.39 | .91 | |
| 13 | N | 20 | 14 | 15 | 17 | |
| | b | -2.28 | 8.78 | -12.34 | 2.86 | |
| | m | 1.21 | 1.06 | 1.40 | 1.04 | |
| 14 | N | 21 | 14 | 14 | 15 | |
| | b | -2.00 | 7.16 | -10.06 | -11.50 | |
| | m | 1.23 | 1.09 | 1.39 | 1.20 | |
| 15 | N | 20 | 13 | 15 | 15 | |
| | b | -4.42 | 3.65 | -5.16 | -29.35 | |
| | m | 1.30 | 1.14 | 1.35 | 1.39 | |
| 16 | N | 19 | 16 | 16 | 5 | |
| | b | -9.55 | -1.72 | 2.36 | -50.69 | |
| | m | 1.39 | 1.20 | 1.28 | 1.59 | |

Table 14. Summary of data for North Target

| TARGET | | NORTH | NORTH | NORTH | NORTH | |
|---|---|---|---|---|---|---|
| HOUR | | SBT-$V_{rT}$ | SBT-$V''_{rP}$ | CBT-$V_{rT}$ | CBT-$V''_{rP}$ | |
| 8 | N | 20 | 20 | 2 | 2 | |
| | $V_r$ av. | 110.4 | 112.6 | 97.9 | 104.0 | |
| | $\sigma$/r | 17.3/.88 | 16.6/— | —/— | —/— | |
| 9 | N | 16 | 16 | 8 | 8 | |
| | $V_r$ av. | 107.0 | 105.4 | 103.2 | 103.9 | |
| | $\sigma$/r | 11.4/.87 | 9.9/— | 25.9/.95 | 22.9/— | |
| 10 | N | 17 | 17 | 8 | 8 | |
| | $V_r$ av. | 102.8 | 101.2 | 110.4 | 112.2 | |
| | $\sigma$/r | 11.2/.71 | 6.1/— | 15.3/.82 | 15.9/— | |
| 11 | N | 10 | 10 | 15 | 15 | |
| | $V_r$ av. | 99.7 | 100.1 | 104.4 | 102.0 | |
| | $\sigma$/r | 10.7/.52 | 7.5/— | 20.8/.85 | 14.6/— | |
| 12 | N | 7 | 7 | 18 | 18 | |
| | $V_r$ av. | 99.9 | 101.1 | 104.6 | 105.1 | |
| | $\sigma$/r | 9.9/.45 | 5.4/— | 18.0/.82 | 16.0/— | |
| 13 | N | 5 | 5 | 20 | 20 | |
| | $V_r$ av. | 100.5 | 102.6 | 95.4 | 97.7 | |
| | $\sigma$/r | 13.6/.83 | 8.2/— | 24.4/.92 | 20.7/— | |
| 14 | N | 3 | 3 | 21 | 21 | |
| | $V_r$ av. | 104.3 | 103.8 | 100.3 | 101.8 | |
| | $\sigma$/r | 10.2/.98 | 12.2/— | 23.0/.93 | 20.3/— | |
| 15 | N | 4 | 4 | 20 | 20 | |
| | $V_r$ av. | 106.4 | 103.3 | 106.1 | 108.4 | |
| | $\sigma$/r | 9.2/.94 | 10.2/— | 23.4/.94 | 24.9/— | |
| 16 | N | 6 | 6 | 19 | 19 | |
| | $V_r$ av. | 115.9 | 115.8 | 111.5 | 109.6 | |
| | $\sigma$/r | 9.3/.64 | 5.4/— | 32.9/.95 | 30.2/— | |

Note: N = Number of hourly observations.
$\sigma$ = Standard deviation.
$V_{rT}$ = Average telephotometric visual range (miles).
$V''_{rP}$ = Average photographic visual range (miles) corrected by linear regression model.
r = Correlation coefficient between $V_{rT}$ and $V''_{rP}$.

Table 15. Summary of data for East Target

| TARGET | | EAST | EAST | EAST | EAST | |
|---|---|---|---|---|---|---|
| HOUR | | SBT-$V_{rT}$ | SBT-$V''_{rP}$ | CBT-$V_{rT}$ | CBT-$V''_{rP}$ | |
| 8 | N | 17 | 17 | 6 | 6 | |
| | $V_r$ av. | 115.2 | 114.9 | 108.7 | 109.5 | |
| | $\sigma$/r | 16.8/.68 | 11.6/— | 23.1/.77 | 17.4/— | |
| 9 | N | 16 | 16 | 8 | 8 | |
| | $V_r$ av. | 111.6 | 109.2 | 113.1 | 109.9 | |
| | $\sigma$/r | 16.1/.68 | 9.3/— | 18.3/.76 | 12.9/— | |
| 10 | N | 16 | 16 | 9 | 9 | |
| | $V_r$ av. | 108.3 | 107.9 | 99.3 | 101.7 | |
| | $\sigma$/r | 11.6/.60 | 6.9/— | 14.9/.84 | 16.6/— | |
| 11 | N | 17 | 17 | 9 | 9 | |
| | $V_r$ av. | 103.0 | 105.2 | 106.5 | 104.0 | |
| | $\sigma$/r | 9.0/.55 | 7.5/— | 17.9/.90 | 14.3/— | |
| 12 | N | 14 | 14 | 11 | 11 | |
| | $V_r$ av. | 101.8 | 102.2 | 112.8 | 111.4 | |
| | $\sigma$/r | 11.5/.70 | 9.1/— | 38.8/.95 | 28.0/— | |
| 13 | N | 11 | 11 | 14 | 14 | |
| | $V_r$ av. | 99.1 | 100.3 | 103.4 | 103.3 | |
| | $\sigma$/r | 11.7/.71 | 7.4/— | 6.0/.93 | 15.5/— | |
| 14 | N | 10 | 10 | 14 | 14 | |
| | $V_r$ av. | 102.5 | 100.9 | 104.5 | 106.3 | |
| | $\sigma$/r | 15.6/.90 | 10.5/— | 13.6/.80 | 14.0/— | |
| 15 | N | 11 | 11 | 13 | 13 | |
| | $V_r$ av. | 107.4 | 105.3 | 100.1 | 101.1 | |
| | $\sigma$/r | 15.2/.85 | 15.4/— | 21.6/.90 | 18.3/— | |
| 16 | N | 9 | 9 | 16 | 16 | |
| | $V_r$ av. | 108.5 | 111.7 | 105.5 | 104.6 | |
| | $\sigma$/r | 13.4/.83 | 11.5/— | 20.6/.80 | 16.1/— | |

Note: N = Number of hourly observations.
$\sigma$ = Standard deviation.
$V_{rT}$ = Average telephotometric visual range (miles).
$V''_{rP}$ = Average photographic visual range (miles) corrected by linear regression model.
r = Correlation coefficient between $V_{rT}$ and $V''_{rP}$.

Table 16. Summary of data for South Target

| TARGET | | SOUTH | SOUTH | SOUTH | SOUTH | |
|---|---|---|---|---|---|---|
| HOUR | | SBT-$V_{rT}$ | SBT-$V''_{rP}$ | CBT-$V_{rT}$ | CBT-$V''_{rP}$ | |
| 8 | N | 17 | 17 | 5 | 5 | |
| | $V_r$ av. | 86.5 | 87.5 | 95.4 | 90.8 | |
| | $\sigma$/r | 10.1/.86 | 7.7/– | 20.5/.98 | 9.9/– | |
| 9 | N | 17 | 17 | 7 | 7 | |
| | $V_r$ av. | 90.8 | 89.7 | 82.5 | 83.2 | |
| | $\sigma$/r | 9.6/.87 | 8.6/– | 13.7/.84 | 11.4/– | |
| 10 | N | 15 | 15 | 10 | 10 | |
| | $V_r$ av. | 94.7 | 94.8 | 89.1 | 88.6 | |
| | $\sigma$/r | 7.0/.74 | 9.9/– | 17.6/.93 | 16.6/– | |
| 11 | N | 18 | 18 | 7 | 7 | |
| | $V_r$ av. | 97.7 | 97.4 | 97.4 | 98.3 | |
| | $\sigma$/r | 10.6/.74 | 7.7/– | 24.9/.85 | 21.9/– | |
| 12 | N | 15 | 15 | 9 | 9 | |
| | $V_r$ av. | 100.1 | 98.2 | 96.0 | 95.2 | |
| | $\sigma$/r | 10.7/.81 | 7.4/– | 13.3/.81 | 15.5/– | |
| 13 | N | 9 | 9 | 15 | 15 | |
| | $V_r$ av. | 104.8 | 105.3 | 92.3 | 91.6 | |
| | $\sigma$/r | 11.8/.89 | 10.8/– | 23.3/.96 | 21.9/– | |
| 14 | N | 10 | 10 | 14 | 14 | |
| | $V_r$ av. | 101.2 | 104.2 | 90.4 | 91.0 | |
| | $\sigma$/r | 14.5/.82 | 10.3/– | 27.9/.95 | 26.7/– | |
| 15 | N | 9 | 9 | 15 | 15 | |
| | $V_r$ av. | 107.5 | 106.6 | 98.7 | 99.1 | |
| | $\sigma$/r | 9.6/.90 | 8.0/– | 26.7/.94 | 24.9/– | |
| 16 | N | 8 | 8 | 16 | 16 | |
| | $V_r$ av. | 105.5 | 104.8 | 98.9 | 98.5 | |
| | $\sigma$/r | 12.4/.43 | 6.5/– | 21.4/.91 | 19.8/– | |

Note: N = Number of hourly observations.
$\sigma$ = Standard deviation.
$V_{rT}$ = Average telephotometric visual range (miles).
$V''_{rP}$ = Average photographic visual range (miles) corrected by linear regression model.
r = Correlation coefficient between $V_{rT}$ and $V''_{rP}$.

Table 17. Summary of data for West Target

| TARGET | | WEST | WEST | WEST | WEST | |
|---|---|---|---|---|---|---|
| HOUR | | SBT-$V_{rT}$ | SBT-$V''_{rP}$ | CBT-$V_{rT}$ | CBT-$V''_{rP}$ | |
| 8 | N | 18 | 18 | 4 | 4 | |
| | $V_r$ av. | 78.3 | 78.8 | 65.4 | 58.3 | |
| | $\sigma$/r | 11.3/.85 | 8.6/— | 7.2/.14 | 2.0/— | |
| 9 | N | 17 | 17 | 7 | 7 | |
| | $V_r$ av. | 79.0 | 78.2 | 63.5 | 66.9 | |
| | $\sigma$/r | 10.1/.70 | 6.4/— | 9.5/.56 | 3.7/— | |
| 10 | N | 14 | 14 | 11 | 11 | |
| | $V_r$ av. | 80.2 | 80.4 | 70.4 | 76.9 | |
| | $\sigma$/r | 7.2/.76 | 5.4/— | 7.3/.61 | 4.6/— | |
| 11 | N | 14 | 14 | 11 | 11 | |
| | $V_r$ av. | 85.6 | 82.0 | 87.2 | 83.2 | |
| | $\sigma$/r | 7.0/-.10 | 4.8/— | 20.6/.84 | 10.0/— | |
| 12 | N | 9 | 9 | 13 | 13 | |
| | $V_r$ av. | 85.6 | 88.1 | 82.7 | 85.3 | |
| | $\sigma$/r | 10.2/.44 | 3.4/— | 13.8/.26 | 7.8/— | |
| 13 | N | 8 | 8 | 17 | 17 | |
| | $V_r$ av. | 96.5 | 89.7 | 88.6 | 93.0 | |
| | $\sigma$/r | 14.9/.81 | 6.9/— | 17.7/.77 | 13.3/— | |
| 14 | N | 9 | 9 | 15 | 15 | |
| | $V_r$ av. | 102.7 | 106.0 | 99.0 | 92.7 | |
| | $\sigma$/r | 14.0/.08 | 5.8/— | 17.3/.53 | 11.8/— | |
| 15 | N | 8 | 8 | 15 | 15 | |
| | $V_r$ av. | 114.2 | 110.5 | 107.7 | 105.9 | |
| | $\sigma$/r | 6.8/.67 | 8.7/— | 19.3/.67 | 12.9/— | |
| 16 | N | 8 | 8 | 15 | 15 | |
| | $V_r$ av. | 118.4 | 123.6 | 115.5 | 115.0 | |
| | $\sigma$/r | 9.7/.87 | 8.8/— | 54.3/.93 | 45.5/— | |

Note: N = Number of hourly observations.
$\sigma$ = Standard deviation.
$V_{rT}$ = Average telephotometric visual range (miles).
$V''_{rP}$ = Average photographic visual range (miles) corrected by linear regression model.
r = Correlation coefficient between $V_{rT}$ and $V''_{rP}$.

and low values of photographic visual range would not be accurately converted to equivalent telephotometric values. Average values of photometric and telephotometric visual ranges would agree within a few percent. Coincidental data for the photographic and telephotometric methods for April-May 1978, and January-February 1979 are yet to be analyzed to determine whether the linear conversion values of b and m derived in this report are valid for all observational periods.

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## APPENDIX:

Hourly values of telephotometric and photographic visual ranges for four targets.

Column 1. TARGET. N, E, S, W. North, East, South and West target designators.

Column 2. Sky. SBT, Sky Behind Target; CBT, Clouds Behind Target.

Column 3. TIME. Time of telephotometric observation.

Column 4. $V_{rT}$. Telephotometric visual range.

Column 5. TIME. Time of photographic observation.

Column 6. $V_{rP}$. Photographic visual range calculated by Martin Marietta Corporation.

Column 7. $V'_{rP}$. Photographic visual range calculated from characteristic curve of film (see section 3.8.2).

Column 8. $V''_{rP}$. Photographic visual range corrected to give values of visual range equivalent to $V_{rT}$ (see section 3.8.2).

| DATE: JULY 7, 1978 (188) | | | | | | | |
|---|---|---|---|---|---|---|---|
| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
| N | SBT | 0836 | 121.6 | 0815 | 79.3 | 101.9 | 123.9 |
| E | | 0845 | 126.8 | 0815 | 77.5 | 105.9 | 112.0 |
| S | | 0848 | 96.4 | 0815 | 66.7 | 81.0 | 91.5 |
| W | | 0851 | 83.1 | 0815 | 64.6 | 78.0 | 80.8 |
| N | | 0909 | 119.1 | 0916 | 76.4 | 95.3 | 117.8 |
| E | | 0911 | 138.7 | 0919 | 77.5 | 102.9 | 110.4 |
| S | | 0918 | 97.0 | 0922 | 62.4 | 77.6 | 91.7 |
| W | | 0922 | 81.6 | 0925 | 64.6 | 77.6 | 80.2 |
| N | | 1010 | 110.7 | 1021 | 70.4 | 86.1 | 101.0 |
| E | | 1022 | 111.7 | 1024 | 73.4 | 92.4 | 104.2 |
| S | | 1024 | 97.0 | 1024 | 58.1 | 73.6 | 91.6 |
| W | | 1028 | 81.4 | 1030 | 64.6 | 76.7 | 80.7 |
| N | | 1118 | 102.9 | 1119 | 64.3 | 77.5 | 93.5 |
| E | | 1119 | 102.7 | 1121 | 73.4 | 90.1 | 102.7 |
| S | | 1122 | 100.3 | 1124 | 60.3 | 78.5 | 97.8 |
| W | | 1128 | 84.9 | 1130 | 60.4 | 71.4 | 79.4 |
| N | | 1209 | 97.3 | 1211 | 64.3 | 77.1 | 97.3 |
| E | | 1212 | 98.1 | 1214 | 69.2 | 82.3 | 96.8 |
| S | | 1215 | 99.6 | 1218 | 55.9 | 72.2 | 94.3 |
| W | | 1219 | 84.7 | 1221 | 64.6 | 77.3 | 84.6 |
| N | | 1303 | 97.4 | 1305 | 70.4 | 85.7 | 97.4 |
| E | | 1305 | 97.6 | 1307 | 69.2 | 81.0 | 94.5 |
| S | | 1309 | 102.9 | 1310 | 58.1 | 76.3 | 98.7 |
| W | | 1311 | 91.4 | 1313 | 60.4 | 72.8 | 81.7 |
| N | | 1408 | 102.1 | 1410 | 67.4 | 82.0 | 98.5 |
| E | | 1410 | 101.0 | 1412 | 69.2 | 82.3 | 94.4 |
| S | | 1413 | 103.8 | 1414 | 58.1 | 75.8 | 99.7 |
| W | | 1415 | 99.4 | 1416 | 68.5 | 86.8 | 100.5 |
| N | | 1506 | 105.3 | 1507 | 67.4 | 82.0 | 98.2 |
| E | | 1508 | 107.2 | 1510 | 77.5 | 96.3 | 107.5 |
| S | | 1511 | 108.9 | 1512 | 62.4 | 83.3 | 104.7 |
| W | | 1513 | 118.6 | 1515 | 68.5 | 89.6 | 103.5 |
| N | | 1602 | 108.7 | 1603 | 73.4 | 90.2 | 109.3 |
| E | | 1604 | 105.1 | 1605 | 77.5 | 98.1 | 109.8 |
| S | | 1606 | 116.8 | 1609 | 62.4 | 81.7 | 102.9 |
| W | SBT | 1610 | 127.3 | 1612 | 79.7 | 112.0 | 123.2 |

DATE: JULY 8, 1978 (189)

| TARGET | SKY | TIME | $V_{r1}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0815 | 114.4 | 0817 | 73.4 | 91.2 | 109.7 |
| E | ↑ | 0818 | 97.5 | 0819 | 69.2 | 93.2 | 103.1 |
| S | \| | 0820 | 81.1 | 0822 | 55.9 | 66.0 | 78.7 |
| W | \| | 0823 | 69.9 | 0824 | 51.1 | 58.8 | 65.7 |
| N | \| | 0907 | 114.5 | 0909 | 73.4 | 90.2 | 106.2 |
| E | \| | 0908 | 108.9 | 0912 | 73.4 | 96.6 | 106.1 |
| S | \| | 0930 | 83.7 | 0916 | 51.6 | 62.3 | 78.7 |
| W | \| | 0917 | 67.1 | 0918 | 55.9 | 65.2 | 71.8 |
| N | ↓ | 1005 | 108.6 | 1007 | 76.4 | 94.2 | 108.3 |
| E | SBT | 1008 | 109.2 | 1009 | 73.4 | 93.6 | 105.0 |
| S | CBT | 1012 | 81.7 | 1011 | 55.9 | 70.9 | 85.9 |
| W | SBT | 1013 | 67.7 | 1014 | 55.9 | 65.2 | 73.8 |
| N | CBT | 1106 | 113.7 | 1108 | 73.4 | 90.2 | 102.7 |
| E | SBT | 1109 | 107.7 | 1110 | 69.2 | 84.4 | 98.6 |
| S | \| | 1114 | 79.8 | 1113 | 47.1 | 58.6 | 81.3 |
| W | SBT | 1116 | 98.5 | 1117 | 51.1 | 58.6 | 72.5 |
| N | CBT | 1205 | 114.7 | 1206 | 73.4 | 90.7 | 105.4 |
| E | SBT | 1207 | 91.2 | 1209 | 64.7 | 75.8 | 91.8 |
| S | \| | 1212 | 82.3 | 1211 | 51.6 | 66.1 | 89.4 |
| W | SBT | 1213 | 98.2 | 1215 | 60.4 | 71.7 | 81.8 |
| N | CBT | 1305 | 101.3 | 1307 | 70.4 | 86.1 | 101.9 |
| E | SBT | 1308 | 85.1 | 1309 | 69.2 | 81.7 | 96.4 |
| S | \| | 1312 | 87.0 | 1312 | 53.8 | 69.7 | 93.7 |
| W | SBT | 1314 | 74.7 | 1316 | 55.9 | 66.6 | 78.6 |
| N | CBT | 1404 | 101.2 | 1406 | 64.3 | 77.5 | 93.3 |
| E | SBT | 1406 | 85.1 | 1408 | 64.7 | 75.8 | 88.0 |
| S | \| | 1410 | 90.2 | 1410 | 51.6 | 66.4 | 92.9 |
| W | SBT | 1412 | 68.1 | 1414 | 60.4 | 75.2 | 94.7 |
| N | CBT | 1505 | 102.9 | 1506 | 67.4 | 82.0 | 102.2 |
| E | SBT | 1507 | 88.4 | 1508 | 64.7 | 77.0 | 86.3 |
| S | \| | 1512 | 97.3 | 1511 | 58.1 | 77.2 | 100.7 |
| W | SBT | 1514 | 101.2 | 1515 | 55.9 | 70.3 | 93.1 |
| N | CBT | 1605 | 99.3 | 1606 | 64.3 | 76.7 | 97.1 |
| E | SBT | 1607 | 92.5 | 1608 | 69.2 | 84.4 | 92.5 |
| S | \| | 1610 | 97.0 | 1609 | 53.8 | 69.0 | 95.4 |
| W | SBT | 1612 | 102.0 | 1613 | 68.5 | 92.5 | 111.6 |

DATE: JULY 9, 1978 (190)

| TARGET | SKY | TIME | $V_{r1}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0819 | 107.7 | 0822 | 73.4 | 92.3 | 110.9 |
| E | CBT | 0820 | 98.3 | 0828 | 69.2 | 92.5 | 97.0 |
| S | SBT | 0832 | 83.0 | 0831 | 68.8 | 84.9 | 94.8 |
| W | \| | 0833 | 79.9 | 0837 | 60.4 | 72.5 | 76.5 |
| N | SBT | 0907 | 105.9 | 0911 | 70.4 | 86.6 | 102.2 |
| E | CBT | 0913 | 122.8 | 0914 | 81.5 | 111.9 | 120.7 |
| S | SBT | 0917 | 89.0 | 0917 | 58.1 | 73.1 | 87.9 |
| W | \| | 0919 | 75.5 | 0921 | 55.9 | 65.9 | 72.3 |
| N | SBT | 1005 | 102.3 | 1007 | 67.4 | 81.6 | 96.9 |
| E | CBT | 1008 | 116.4 | 1009 | 77.5 | 101.6 | 111.1 |
| S | SBT | 1011 | 95.4 | 1010 | 62.4 | 80.7 | 97.7 |
| W | \| | 1012 | 82.1 | 1013 | 68.5 | 82.8 | 84.4 |
| N | SBT | 1105 | 99.6 | 1106 | 70.4 | 86.1 | 100.3 |
| E | CBT | 1107 | 111.1 | 1108 | 77.5 | 96.8 | 108.1 |
| S | SBT | 1110 | 105.0 | 1109 | 62.4 | 81.7 | 100.5 |
| W | SBT | 1112 | 87.9 | 1115 | 72.4 | 86.8 | 87.7 |
| N | CBT | 1205 | 109.6 | 1207 | 76.4 | 95.3 | 109.6 |
| E | \| | 1208 | 118.8 | 1210 | 81.5 | 100.6 | 114.6 |
| S | CBT | 1212 | 114.6 | 1211 | 66.7 | 89.3 | 112.1 |
| W | SBT | 1213 | 67.3 | 1214 | 68.5 | 82.4 | 87.2 |
| N | CBT | 1302 | 116.4 | 1304 | 73.4 | 91.7 | 108.7 |
| E | \| | 1304 | 112.9 | 1305 | 77.5 | 94.1 | 108.5 |
| S | CBT | 1307 | 120.2 | 1307 | 66.7 | 91.1 | 115.2 |
| W | SBT | 1308 | 96.7 | 1310 | 68.5 | 84.6 | 87.4 |
| N | CBT | 1402 | 117.7 | 1404 | 73.4 | 91.7 | 110.8 |
| E | \| | 1405 | 118.5 | 1406 | 77.5 | 93.7 | 109.3 |
| S | CBT | 1408 | 118.8 | 1408 | 66.7 | 90.5 | 115.7 |
| W | SBT | 1411 | 110.9 | 1411 | 72.4 | 92.1 | 103.2 |
| N | CBT | 1502 | 114.1 | 1503 | 73.4 | 90.7 | 113.5 |
| E | \| | 1505 | 112.9 | 1506 | 73.4 | 89.7 | 105.9 |
| S | CBT | 1509 | 109.5 | 1509 | 71.0 | 95.1 | 123.2 |
| W | SBT | 1512 | 109.8 | 1513 | 76.1 | 101.4 | 109.9 |
| N | CBT | 1601 | 122.2 | 1604 | 76.4 | 95.3 | 122.9 |
| E | \| | 1604 | 113.5 | 1605 | 73.4 | 92.0 | 108.7 |
| S | CBT | 1607 | 109.1 | 1607 | 64.5 | 84.3 | 110.3 |
| W | SBT | 1608 | 113.3 | 1611 | 76.1 | 103.7 | 118.4 |

DATE: JULY 10, 1978 (191)

| TARGET | SKY | TIME | $V_{r1}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | CBT | 0802 | 112.9 | 0803 | 79.3 | 97.0 | 117.3 |
| E | SBT | 0803 | 118.9 | 0807 | 81.5 | 113.3 | 117.2 |
| S | CBT | 0808 | 93.3 | 0807 | 64.5 | 75.5 | 93.3 |
| W | SBT | 0809 | 81.5 | 0813 | 72.4 | 86.4 | 87.5 |
| N | CBT | 0901 | 109.0 | 0903 | 79.3 | 95.8 | 109.4 |
| E | \| | 0903 | 132.7 | 0905 | 89.3 | 119.9 | 129.6 |
| S | CBT | 0907 | 108.2 | 0907 | 75.3 | 80.3 | 97.1 |
| W | SBT | 0908 | 64.1 | 0910 | 60.4 | 68.3 | 73.9 |
| N | CBT | 1002 | 100.8 | 1004 | 70.4 | 85.7 | 95.4 |
| E | ↑ | 1005 | 116.9 | 1006 | 81.5 | 104.5 | 114.2 |
| S | ↑ | 1008 | 108.8 | 1008 | 68.8 | 82.4 | 100.4 |
| W | ↑ | 1011 | 79.4 | 1012 | 64.6 | 76.7 | 78.6 |
| N | ↑ | 1103 | 95.8 | 1105 | 67.4 | 82.9 | 93.5 |
| E | ↑ | 1106 | 109.9 | 1107 | 73.4 | 90.4 | 101.3 |
| S | ↓ | 1110 | 85.4 | 1109 | 60.3 | 78.5 | 96.2 |
| W | CBT | 1111 | 92.7 | 1115 | 72.4 | 86.4 | 89.3 |
| N | SBT | 1201 | 94.7 | 1203 | 67.4 | 80.7 | 96.5 |
| E | CBT | 1204 | 100.0 | 1205 | 77.5 | 94.6 | 107.9 |
| S | ↑ | 1207 | 90.2 | 1207 | 53.8 | 69.0 | 83.9 |
| W | ↑ | 1209 | 78.7 | 1210 | 72.4 | 85.6 | 91.6 |
| N | ↑ | 1302 | 96.5 | 1303 | 67.4 | 79.4 | 93.8 |
| E | ↑ | 1304 | 105.2 | 1305 | 77.5 | 90.6 | 104.8 |
| S | ↑ | 1306 | 34.6 | 1306 | 31.6 | 34.5 | 36.0 |
| W | ↑ | 1307 | 110.5 | 1309 | 86.9 | 99.2 | 106.0 |
| N | ↑ | 1404 | 109.5 | 1406 | 67.4 | 82.9 | 97.0 |
| E | ↑ | 1407 | 112.3 | 1408 | 85.4 | 83.3 | 98.0 |
| S | ↑ | 1411 | 43.2 | 1411 | 34.6 | 40.5 | 46.2 |
| W | ↑ | 1413 | 101.2 | 1414 | 76.1 | 89.1 | 95.4 |
| N | ↑ | 1503 | 108.6 | 1504 | 79.3 | 93.3 | 116.9 |
| E | ↑ | 1505 | 93.2 | 1507 | 73.4 | 84.9 | 100.4 |
| S | ↑ | 1509 | 96.7 | 1509 | 71.0 | 84.4 | 108.8 |
| W | ↑ | 1512 | 95.6 | 1512 | 79.7 | 95.3 | 103.1 |
| N | ↑ | 1601 | 151.6 | 1602 | 91.1 | 106.4 | 138.4 |
| E | ↓ | 1603 | 88.4 | 1604 | 69.2 | 70.2 | 82.5 |
| S | ↓ | 1606 | 73.8 | 1606 | 51.6 | 51.0 | 67.6 |
| W | CBT | 1607 | 122.2 | 1608 | 86.9 | 105.8 | 117.5 |

DATE: JULY 14, 1978 (195)

| TARGET | SKY | TIME | $V_{rI}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0819 | 144.8 | 0820 | 96.9 | 123.6 | 153.4 |
| E | ↑ | 0821 | 123.3 | 0822 | 93.1 | 136.1 | 133.1 |
| S | ↓ | 0824 | 107.7 | 0824 | 79.7 | 100.4 | 108.0 |
| W | SBT | 0825 | 95.0 | 0826 | 76.1 | 95.5 | 94.7 |
| N | CBT | 0912 | 141.4 | 0914 | 88.1 | 111.6 | 132.4 |
| E | SBT | 0913 | 131.5 | 0918 | 89.3 | 124.7 | 125.2 |
| S | 1 | 0925 | 113.8 | 0923 | 77.5 | 101.6 | 112.1 |
| W | SBT | 0926 | 96.7 | 0930 | 76.1 | 95.0 | 92.1 |
| N | CBT | 1004 | 130.7 | 1005 | 94.0 | 120.5 | 142.1 |
| E | SBT | 1005 | 130.5 | 1007 | 85.4 | 114.3 | 119.3 |
| S | CBT | 1010 | 113.1 | 1009 | 73.1 | 96.2 | 117.8 |
| W | 1 | 1011 | 74.0 | 1014 | 72.4 | 88.9 | 87.2 |
| N | CBT | 1104 | 124.3 | 1107 | 85.2 | 107.5 | 124.5 |
| E | SBT | 1107 | 125.4 | 1108 | 89.3 | 113.9 | 126.0 |
| S | CBT | 1111 | 117.3 | 1110 | 71.0 | 95.8 | 119.3 |
| W | 1 | 1112 | 94.0 | 1113 | 76.1 | 93.7 | 95.1 |
| N | CBT | 1203 | 136.0 | 1204 | 88.1 | 113.8 | 133.6 |
| E | SBT | 1204 | 123.4 | 1206 | 89.3 | 111.6 | 119.7 |
| S | CBT | 1209 | 119.8 | 1208 | 71.0 | 97.2 | 123.1 |
| W | 1 | 1211 | 72.1 | 1212 | 79.7 | 98.8 | 103.6 |
| N | CBT | 1305 | 128.2 | 1306 | 79.3 | 100.6 | 119.5 |
| E | SBT | 1307 | 114.5 | 1308 | 85.4 | 106.1 | 116.1 |
| S | CBT | 1312 | 119.4 | 1311 | 71.0 | 97.9 | 124.7 |
| W | 1 | 1312 | 116.2 | 1314 | 90.4 | 117.2 | 124.7 |
| N | CBT | 1403 | 142.6 | 1405 | 88.1 | 115.4 | 139.9 |
| E | SBT | 1406 | 130.3 | 1407 | 89.3 | 112.2 | 123.4 |
| S | CBT | 1410 | 113.2 | 1409 | 73.1 | 101.3 | 130.7 |
| W | 1 | 1411 | 112.4 | 1414 | 83.3 | 109.4 | 111.8 |
| N | CBT | 1502 | 157.1 | 1504 | 96.9 | 127.3 | 161.1 |
| E | SBT | 1504 | 128.8 | 1506 | 93.1 | 122.2 | 154.4 |
| S | CBT | 1508 | 142.0 | 1509 | 79.7 | 111.6 | 145.5 |
| W | 1 | 1510 | 108.3 | 1511 | 79.7 | 105.9 | 117.9 |
| N | CBT | 1602 | 154.9 | 1604 | 96.9 | 115.5 | 151.0 |
| E | SBT | 1605 | 131.1 | 1606 | 85.4 | 110.0 | 126.0 |
| S | CBT | 1609 | 121.9 | 1608 | 77.5 | 103.2 | 134.5 |
| W | CBT | 1610 | 95.6 | 1610 | 79.7 | 107.4 | 120.2 |

DATE: JULY 15, 1978 (196)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | CBT | 0813 | 126.3 | 0815 | 79.3 | 102.5 | —— |
| E | ↑ | 0816 | 148.4 | 0818 | 96.8 | 123.7 | 133.5 |
| S | | 0822 | 81.0 | 0821 | 53.8 | 65.2 | 81.4 |
| W | | 0823 | 59.4 | 0825 | 51.1 | 58.2 | 55.9 |
| N | | 0903 | 135.6 | 0905 | 91.1 | 113.2 | 134.8 |
| E | | 0906 | 122.7 | 0907 | 89.3 | 109.8 | 118.4 |
| S | | 0910 | 80.0 | 0909 | 60.3 | 71.3 | 86.7 |
| W | | 0912 | 63.7 | 0913 | 60.4 | 63.9 | 65.6 |
| N | | 1002 | 128.4 | 1003 | 85.2 | 108.2 | 125.6 |
| E | | 1005 | 111.0 | 1006 | 81.5 | 101.6 | 111.1 |
| S | | 1009 | 59.7 | 1008 | 44.8 | 55.9 | 67.0 |
| W | | 1010 | 59.3 | 1015 | 60.4 | 69.4 | 73.5 |
| N | | 1102 | 152.4 | 1103 | 102.8 | 107.5 | 124.5 |
| E | | 1104 | 126.5 | 1105 | 93.1 | 104.5 | 116.1 |
| S | | 1108 | 140.2 | 1107 | 73.1 | 94.7 | 117.9 |
| W | | 1109 | 122.0 | 1110 | 90.4 | 99.2 | 99.4 |
| N | | 1202 | 106.3 | 1204 | 61.2 | 76.3 | 87.8 |
| E | | 1203 | 221.1 | 1206 | 126.6 | 163.3 | 180.0 |
| N | | 1303 | 86.3 | 1305 | 64.3 | 78.6 | 92.8 |
| E | | 1306 | 108.6 | 1306 | 77.5 | 89.2 | 103.3 |
| S | | 1310 | 80.3 | 1310 | 47.1 | 61.2 | 73.3 |
| W | | 1311 | 78.3 | 1314 | 72.4 | 93.0 | 99.6 |
| N | | 1403 | 119.6 | 1405 | 76.4 | 97.0 | 117.3 |
| E | | 1406 | 108.3 | 1407 | 73.4 | 92.0 | 107.4 |
| S | | 1410 | 115.4 | 1410 | 64.5 | 90.0 | 115.0 |
| W | | 1411 | 117.5 | 1412 | 76.1 | 99.6 | 108.0 |
| N | | 1503 | 114.9 | 1505 | 73.4 | 94.3 | 118.2 |
| E | | 1505 | 93.5 | 1507 | 59.9 | 70.5 | 84.0 |
| S | ↓ | 1510 | 88.0 | 1509 | 55.9 | 75.1 | 96.2 |
| W | CBT | 1511 | 130.6 | 1512 | 79.7 | 110.5 | 124.2 |
| N | SBT | 1602 | 118.5 | 1604 | 76.4 | 95.9 | 118.5 |
| E | CBT | 1604 | 101.0 | 1605 | 69.2 | 83.0 | 97.9 |
| S | \| | 1609 | 107.9 | 1608 | 60.3 | 82.4 | 107.8 |
| W | CBT | 1610 | 102.9 | 1611 | 72.4 | 100.3 | 108.8 |
| | | | | | | | |
| | | | | | | | |

DATE: JULY 16, 1978 (197)

| TARGET | SKY | TIME | $V_{r1}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | CBT | —— | —— | 0920 | 67.4 | —— | —— |
| E | ↑ | —— | —— | 0920 | 64.7 | —— | —— |
| S | | —— | —— | —— | —— | —— | —— |
| W | | —— | —— | —— | —— | —— | —— |
| N | | —— | —— | 0920 | 70.4 | 93.2 | 105.6 |
| E | | —— | —— | 0920 | 73.4 | 93.9 | 100.8 |
| S | | —— | —— | 0920 | 60.3 | 78.1 | 85.1 |
| W | | —— | —— | 0920 | 64.6 | 79.6 | 75.5 |
| N | | 1004 | 107.6 | 1006 | 73.4 | 99.8 | 107.6 |
| E | | 1006 | 70.1 | 1007 | 54.7 | 59.8 | 66.4 |
| S | | 1011 | 110.2 | 1011 | 64.5 | 88.3 | 107.8 |
| W | | 1012 | 76.4 | 1013 | 60.4 | 72.5 | 75.7 |
| N | | 1103 | 99.2 | 1105 | 67.4 | 89.4 | 101.7 |
| E | | 1106 | 117.3 | 1107 | 77.5 | 98.5 | 109.8 |
| S | | 1110 | 105.5 | 1110 | 66.7 | 96.6 | 120.4 |
| W | | 1111 | 123.2 | 1114 | 68.5 | 85.7 | 88.8 |
| N | | 1203 | 103.4 | 1205 | 76.4 | 103.2 | 120.62 |
| E | | 1205 | 109.9 | 1207 | 77.5 | 101.6 | 115.2 |
| S | | 1210 | 88.5 | 1209 | 55.9 | 77.2 | 95.3 |
| W | | 1211 | 75.3 | 1213 | 64.6 | 76.7 | 83.5 |
| N | | 1314 | 119.0 | 1316 | 79.3 | 102.5 | 121.8 |
| E | | 1316 | 95.3 | 1317 | 69.2 | 83.0 | 96.8 |
| S | | 1319 | 67.8 | 1318 | 49.4 | 59.3 | 70.7 |
| W | | 1320 | 108.5 | 1320 | 83.3 | 93.3 | 99.9 |
| N | | 1402 | 114.2 | 1403 | 79.3 | 100.6 | 121.7 |
| E | | 1403 | 104.8 | 1403 | 77.5 | 94.1 | 109.7 |
| S | | 1405 | 37.7 | 1405 | 31.6 | 37.5 | 42.1 |
| W | | 1406 | 109.6 | 1407 | 68.5 | 79.5 | 83.9 |
| E | | 1545 | 113.2 | 1547 | 93.1 | 76.8 | 90.4 |
| S | ↓ | 1549 | 52.1 | 1549 | 40.0 | 40.9 | 54.7 |
| W | | 1550 | 126.7 | 1551 | 86.9 | 119.9 | 140.0 |
| N | CBT | 1556 | 76.1 | 1556 | 54.6 | 54.1 | —— |
| N | | | | | | | |
| E | | | | | | | |
| S | | | | | | | |
| W | | | | | | | |

DATE: JULY 17, 1978 (198)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0804 | 84.6 | 0805 | 57.9 | 72.7 | 84.2 |
| E | SBT | 0806 | 118.5 | 0807 | 81.5 | 116.8 | 119.6 |
| S | CBT | 0810 | 75.7 | 0809 | 53.8 | 65.2 | 81.4 |
| W | SBT | 0812 | 56.4 | 0813 | 51.1 | 60.5 | 67.0 |
| N | SBT | 0902 | 79.0 | 0904 | 57.9 | 71.8 | 85.9 |
| E | CBT | 0905 | 100.2 | 0906 | 73.4 | 102.4 | 110.1 |
| S | ↑ | 0909 | 70.0 | 0908 | 47.1 | 59.2 | 72.8 |
| W | CBT | 0910 | 59.9 | 0912 | 60.4 | 73.9 | 71.9 |
| N | SBT | 1002 | 75.0 | 1004 | 57.9 | 72.4 | 88.5 |
| E | CBT | 1005 | 90.3 | 1006 | 64.7 | 84.0 | 92.3 |
| S | ↑ | 1009 | 79.6 | 1008 | 51.6 | 66.4 | 80.2 |
| W | ↑ | 1010 | 67.6 | 1012 | 60.4 | 73.9 | 73.9 |
| N | ↑ | 1103 | 79.2 | 1104 | 61.2 | 76.8 | 85.8 |
| E | ↑ | 1105 | 88.4 | 1106 | 64.7 | 82.5 | 93.0 |
| S | ↑ | 1109 | 71.5 | 1108 | 51.6 | 66.4 | 79.9 |
| W | ↑ | 1119 | 66.1 | 1121 | 51.1 | 55.7 | 65.1 |
| N | ↑ | 1202 | 102.1 | 1203 | 73.4 | 96.4 | 112.3 |
| E | ↑ | 1204 | 96.5 | 1204 | 73.4 | 87.3 | 100.2 |
| S | ↑ | 1207 | 87.3 | 1205 | 55.9 | 58.2 | 68.9 |
| N | ↑ | 1301 | 105.6 | 1302 | 70.4 | 72.8 | 85.8 |
| E | ↑ | 1303 | 97.8 | 1303 | 69.2 | 78.6 | 92.1 |
| W | ↑ | 1304 | 85.7 | 1304 | 69.6 | 75.1 | 81.0 |
| N | ↑ | 1503 | 117.1 | 1505 | 79.3 | 80.6 | 100.4 |
| E | ↑ | 1506 | 148.8 | 1507 | 104.3 | 112.7 | 132.1 |
| S | ↑ | 1510 | 64.6 | 1510 | 47.1 | 48.5 | 60.3 |
| W | ↑ | 1511 | 133.8 | 1513 | 97.3 | 111.5 | 125.6 |
| N | ↑ | 1602 | 171.0 | 1603 | 102.8 | 107.0 | 139.2 |
| E | ↑ | 1604 | 127.2 | 1605 | 85.4 | 95.5 | 112.9 |
| S | ↓ | 1607 | 90.9 | 1606 | 51.6 | 65.3 | 85.9 |
| W | CBT | 1608 | 304.9 | 1608 | 173.5 | 191.6 | 254.0 |
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DATE: JULY 18, 1978 (199)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0804 | 106.7 | 0806 | 70.4 | 88.0 | 105.2 |
| E | ↑ | 0807 | 160.2 | 0809 | 100.6 | 150.3 | 160.2 |
| S | ↑ | 0811 | 88.7 | 0810 | 60.3 | 74.2 | 85.7 |
| W | ↑ | 0812 | 68.5 | 0814 | 51.1 | 60.0 | 66.6 |
| N | ↓ | 0904 | 105.5 | 0905 | 67.4 | 84.6 | 100.0 |
| E | ↓ | 0906 | 127.9 | 0907 | 81.5 | 114.8 | 118.5 |
| S | SBT | 0910 | 82.7 | 0909 | 51.6 | 64.0 | 80.1 |
| W | CBT | 0911 | 82.3 | 0912 | 60.4 | 71.1 | 70.1 |
| N | SBT | 1003 | 105.9 | 1004 | 73.4 | 92.3 | 106.6 |
| E | \| | 1005 | 129.5 | 1006 | 85.4 | 114.3 | 119.3 |
| S | SBT | 1007 | 99.4 | 1008 | 71.0 | 87.7 | 103.6 |
| W | CBT | 1009 | 71.7 | 1010 | 64.6 | 76.0 | 78.1 |
| N | CBT | 1104 | 102.2 | 1106 | 70.4 | 89.0 | 101.2 |
| E | SBT | 1107 | 106.2 | 1109 | 73.4 | 92.8 | 104.6 |
| S | SBT | 1112 | 99.8 | 1111 | 60.3 | 81.0 | 99.9 |
| W | CBT | 1113 | 72.5 | 1115 | 55.9 | 66.6 | 73.7 |
| N | CBT | 1204 | 105.7 | 1205 | 73.4 | 93.3 | 108.6 |
| E | SBT | 1206 | 102.6 | 1207 | 77.5 | 97.2 | 108.5 |
| S | CBT | 1210 | 91.5 | 1210 | 55.9 | 75.1 | 92.4 |
| W | \| | 1211 | 73.5 | 1213 | 60.4 | 73.0 | 80.1 |
| N | CBT | 1303 | 84.4 | 1305 | 64.3 | 79.4 | 93.8 |
| E | SBT | 1306 | 96.9 | 1307 | 69.2 | 83.0 | 96.3 |
| S | CBT | 1310 | 84.8 | 1310 | 53.8 | 72.8 | 89.6 |
| W | \| | 1312 | 76.7 | 1312 | 60.4 | 74.7 | 80.5 |
| N | CBT | 1402 | 94.1 | 1403 | 67.4 | 84.6 | 102.1 |
| E | SBT | 1404 | 94.1 | 1405 | 69.2 | 83.7 | 95.7 |
| S | CBT | 1408 | 58.6 | 1407 | 40.0 | 50.1 | 59.6 |
| W | ↑ | 1408 | 84.6 | 1410 | 64.6 | 83.0 | 88.1 |
| N | ↑ | 1502 | 88.2 | 1503 | 61.2 | 70.2 | 86.8 |
| E | ↑ | 1503 | 102.3 | 1504 | 73.4 | 83.7 | 99.1 |
| S | ↑ | 1505 | 59.8 | 1506 | 40.0 | 47.4 | 58.8 |
| W | ↑ | 1507 | 96.0 | 1507 | 76.1 | 94.1 | 101.4 |
| N | ↓ | 1601 | 51.0 | 1603 | 38.4 | 42.0 | 48.8 |
| E | ↓ | 1604 | 81.3 | 1605 | 73.4 | 90.8 | 107.2 |
| S | CBT | 1608 | 73.2 | 1607 | 51.6 | 65.7 | 86.5 |
| W | | 1611 | 71.6 | 1609 | 51.1 | 59.8 | 44.4 |

| DATE: JULY 20, 1978 (201) | | | | | | | |
|---|---|---|---|---|---|---|---|
| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
| N | SBT | 0804 | 107.3 | 0805 | 73.4 | 97.5 | 117.9 |
| E | CBT | 0806 | 118.9 | 0807 | 81.5 | 119.7 | 128.8 |
| S | SBT | 0809 | 89.5 | 0809 | 64.5 | 82.7 | 92.9 |
| W | SBT | 0811 | 94.7 | 0812 | 72.4 | 93.0 | 92.7 |
| N | CBT | 0904 | 114.7 | 0905 | 76.4 | 99.8 | 115.2 |
| E | CBT | 0906 | 118.9 | 0908 | 81.5 | 116.3 | 125.6 |
| S | SBT | 0910 | 98.2 | 0909 | 66.7 | 88.1 | 100.6 |
| W | I | 0912 | 92.1 | 0913 | 72.4 | 91.7 | 89.8 |
| N | SBT | 1004 | 110.0 | 1006 | 70.4 | 88.0 | 102.7 |
| E | CBT | 1007 | 103.0 | 1008 | 81.5 | 112.4 | 122.7 |
| S | SBT | 1010 | 107.4 | 1009 | 71.0 | 97.2 | 111.7 |
| W | SBT | 1011 | 88.7 | 1013 | 76.1 | 96.9 | 92.8 |
| N | CBT | 1104 | 109.0 | 1105 | 76.4 | 97.6 | 112.0 |
| E | SBT | 1105 | 117.4 | 1107 | 85.4 | 112.1 | 118.5 |
| S | I | 1109 | 119.1 | 1108 | 73.1 | 102.7 | 117.9 |
| W | SBT | 1110 | 90.9 | 1111 | 68.5 | 83.9 | 86.2 |
| N | CBT | 1204 | 120.9 | 1205 | 82.3 | 108.8 | 127.5 |
| E | CBT | 1212 | 128.2 | 1213 | 89.3 | 114.5 | 128.8 |
| S | SBT | 1216 | 124.1 | 1216 | 68.8 | 95.8 | 113.2 |
| W | SBT | 1218 | 83.7 | 1219 | 76.1 | 95.5 | 93.7 |
| N | CBT | 1303 | 127.5 | 1305 | 82.3 | 106.1 | 126.1 |
| E | CBT | 1305 | 131.4 | 1306 | 93.1 | 118.9 | 134.8 |
| S | SBT | 1311 | 119.6 | 1310 | 73.1 | 106.5 | 121.6 |
| W | SBT | 1312 | 99.7 | 1313 | 79.7 | 103.9 | 96.9 |
| N | CBT | 1403 | 124.0 | 1405 | 85.2 | 113.2 | 137.2 |
| E | CBT | 1406 | 127.6 | 1407 | 89.3 | 115.7 | 133.3 |
| S | SBT | 1409 | 108.5 | 1409 | 71.0 | 102.0 | 118.5 |
| W | SBT | 1410 | 98.4 | 1412 | 79.7 | 107.4 | 110.8 |
| N | CBT | 1503 | 1409 | 1505 | 82.3 | 106.1 | 133.5 |
| E | CBT | 1506 | 129.2 | 1506 | 93.1 | 121.5 | 142.2 |
| S | SBT | 1507 | 125.3 | 1508 | 79.7 | 110.7 | 122.8 |
| W | SBT | 1510 | 122.3 | 1510 | 86.9 | 118.7 | 119.3 |
| N | CBT | 1603 | 127.0 | 1605 | 85.2 | 104.0 | 135.0 |
| E | CBT | 1605 | 150.0 | 1606 | 100.6 | 125.3 | 148.6 |
| S | SBT | 1609 | 85.8 | 1609 | 73.1 | 92.6 | 109.3 |
| W | SBT | 1611 | 123.3 | 1612 | 83.3 | 113.4 | 124.2 |

DATE: JULY 21, 1978 (202)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0810 | 91.4 | 0812 | 64.3 | 81.0 | 95.5 |
| E | ↑ | 0813 | 101.9 | 0814 | 69.2 | 94.8 | 104.2 |
| S | ↓ | 0817 | 70.6 | 0816 | 53.8 | 65.9 | 78.7 |
| W | SBT | 0818 | 66.9 | 0820 | 60.4 | 73.6 | 77.4 |
| N | CBT | 0905 | 83.7 | 0906 | 61.2 | 76.1 | 80.6 |
| E | SBT | 0907 | 91.2 | 0908 | 64.7 | 85.9 | 98.8 |
| S | \| | 0911 | 76.5 | 0910 | 55.9 | 71.3 | 86.3 |
| W | SBT | 0912 | 68.3 | 0914 | 60.4 | 73.6 | 77.5 |
| N | CBT | 1002 | 115.7 | 1004 | 73.4 | 94.3 | 107.0 |
| E | SBT | 1005 | 91.0 | 1006 | 73.4 | 97.0 | 107.4 |
| S | \| | 1009 | 90.2 | 1008 | 58.1 | 76.3 | 93.9 |
| W | SBT | 1011 | 84.1 | 1012 | 72.4 | 78.6 | 81.8 |
| N | CBT | 1102 | 126.8 | 1104 | 82.3 | 108.8 | 126.1 |
| E | SBT | 1105 | 97.9 | 1106 | 73.4 | 93.2 | 104.9 |
| S | \| | 1109 | 96.2 | 1108 | 64.5 | 88.3 | 106.0 |
| W | SBT | 1110 | 75.1 | 1111 | 68.5 | 84.6 | 86.5 |
| N | CBT | 1204 | 108.0 | 1205 | 73.4 | 94.3 | 109.8 |
| E | SBT | 1206 | 98.9 | 1207 | 73.4 | 91.2 | 103.8 |
| S | \| | 1209 | 96.7 | 1209 | 62.4 | 85.9 | 105.3 |
| W | SBT | 1210 | 88.4 | 1211 | 64.6 | 78.6 | 85.3 |
| N | CBT | 1304 | 123.6 | 1305 | 79.3 | 104.3 | 123.9 |
| E | SBT | 1307 | 103.1 | 1310 | 77.5 | 95.4 | 106.9 |
| S | \| | 1316 | 105.6 | 1315 | 64.5 | 89.4 | 108.6 |
| W | SBT | 1318 | 82.3 | 1320 | 68.5 | 86.4 | 88.3 |
| N | CBT | 1404 | 118.2 | 1405 | 76.4 | 99.3 | 120.1 |
| E | SBT | 1406 | 105.2 | 1407 | 77.5 | 96.3 | 107.9 |
| S | \| | 1410 | 111.4 | 1410 | 68.8 | 96.4 | 114.5 |
| W | SBT | 1411 | 106.5 | 1412 | 79.7 | 106.4 | 110.3 |
| N | CBT | 1504 | 129.8 | 1506 | 85.2 | 111.8 | 140.9 |
| E | SBT | 1507 | 109.1 | 1507 | 81.5 | 103.5 | 115.4 |
| S | \| | 1510 | 110.3 | 1509 | 68.8 | 95.8 | 113.0 |
| W | SBT | 1511 | 116.5 | 1511 | 76.1 | 101.9 | 110.2 |
| N | CBT | 1602 | 122.0 | 1604 | 79.3 | 100.6 | 130.3 |
| E | SBT | 1604 | 114.2 | 1605 | 81.5 | 106.0 | 119.7 |
| S | \| | 1607 | 121.8 | 1607 | 71.0 | 97.2 | 112.1 |
| W | SBT | 1608 | 131.9 | 1609 | 93.9 | 139.2 | 139.7 |

| DATE: JULY 22, 1978 (203) | | | | | | | |
|---|---|---|---|---|---|---|---|
| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
| N | SBT | 0804 | 112.3 | 0806 | 76.4 | 101.5 | 121.4 |
| E | ↑ | 0807 | 109.1 | 0808 | 77.5 | 112.0 | 116.3 |
| S | | 0810 | 89.7 | 0809 | 62.4 | 80.2 | 90.8 |
| W | | 0812 | 87.0 | 0813 | 64.6 | 81.4 | 83.5 |
| N | | 0908 | 110.1 | 0909 | 94.0 | 101.5 | 118.6 |
| E | | 0910 | 108.6 | 0911 | 73.4 | 102.4 | 110.1 |
| S | | 0913 | 92.4 | 0912 | 60.3 | 79.5 | 93.3 |
| W | | 0914 | 84.3 | 0915 | 60.4 | 74.4 | 78.1 |
| N | | 1001 | 107.4 | 1002 | 73.4 | 94.3 | 108.4 |
| E | | 1005 | 109.1 | 1006 | 77.5 | 105.1 | 112.9 |
| S | | 1009 | 95.8 | 1008 | 62.4 | 84.3 | 100.7 |
| W | | 1010 | 87.9 | 1011 | 68.5 | 86.0 | 86.3 |
| N | | 1101 | 107.3 | 1102 | 73.4 | 94.3 | 106.8 |
| E | | 1102 | 110.3 | 1104 | 81.5 | 107.3 | 115.1 |
| S | | 1105 | 104.6 | 1105 | 62.4 | 85.4 | 103.6 |
| W | | 1107 | 89.3 | 1108 | 72.4 | 91.3 | 90.2 |
| N | | 1202 | 110.0 | 1203 | 76.4 | 99.3 | 110.5 |
| E | | 1204 | 111.4 | 1205 | 81.5 | 103.5 | 113.4 |
| S | | 1208 | 106.4 | 1207 | 66.7 | 94.1 | 95.8 |
| W | | 1210 | 92.0 | 1210 | 72.4 | 91.7 | 91.8 |
| N | | 1301 | 115.4 | 1302 | 79.3 | 104.9 | 115.5 |
| E | | 1303 | 113.3 | 1304 | 77.5 | 96.8 | 108.1 |
| S | | 1306 | 107.9 | 1306 | 68.8 | 94.7 | 116.5 |
| W | | 1308 | 123.9 | 1309 | 79.7 | 105.4 | 97.6 |
| N | | 1401 | 115.5 | 1402 | 79.3 | 103.7 | 117.8 |
| E | | 1402 | 119.7 | 1404 | 77.5 | 96.3 | 107.9 |
| S | | 1405 | 111.7 | 1406 | 68.8 | 99.7 | 116.9 |
| W | | 1406 | 112.8 | 1408 | 79.7 | 108.4 | 111.3 |
| N | | 1500 | 118.4 | 1501 | 76.4 | 98.1 | 115.3 |
| E | | 1502 | 120.5 | 1503 | 81.5 | 105.0 | 117.1 |
| S | | 1505 | 107.2 | 1505 | 68.8 | 99.0 | 115.1 |
| W | | 1506 | 120.6 | 1507 | 79.7 | 112.0 | 115.6 |
| N | | 1601 | 116.1 | 1602 | 79.3 | 101.2 | 123.7 |
| E | | 1603 | 118.5 | 1603 | 81.5 | 105.5 | 119.1 |
| S | ↓ | 1606 | 109.9 | 1606 | 68.8 | 95.1 | 110.8 |
| W | SBT | 1607 | 121.9 | 1608 | 83.3 | 120.7 | 128.6 |

| DATE: JULY 23, 1978 (204) | | | | | | | |
|---|---|---|---|---|---|---|---|
| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
| N | SBT | 0804 | 126.0 | 0805 | 76.4 | 92.0 | 110.5 |
| E | ↑ | 0806 | 130.9 | 0807 | 69.2 | 90.2 | 101.0 |
| S | \| | 0808 | 94.6 | 0808 | 66.7 | 78.6 | 89.5 |
| W | \| | 0809 | 95.0 | 0810 | 68.5 | 82.4 | 84.3 |
| N | \| | 0901 | 119.7 | 0902 | 79.3 | 96.4 | 113.0 |
| E | \| | 0903 | 129.6 | 0904 | 73.4 | 95.1 | 105.1 |
| S | \| | 0905 | 97.0 | 0905: | 62.4 | 76.0 | 90.3 |
| W | \| | 0906 | 98.2 | 0908 | 64.6 | 76.7 | 79.6 |
| N | \| | 1001 | 116.9 | 1002 | 73.4 | 87.1 | 101.9 |
| E | \| | 1002 | 121.8 | 1004 | 73.4 | 90.8 | 103.1 |
| S | \| | 1006 | 102.9 | 1006 | 60.3 | 73.7 | 91.7 |
| W | \| | 1007 | 91.1 | 1008 | 64.6 | 76.0 | 80.3 |
| N | \| | 1101 | 116.3 | 1102 | 79.3 | 94.6 | 107.0 |
| E | \| | 1103 | 115.6 | 1104 | 77.5 | 94.6 | 105.9 |
| S | \| | 1105 | 112.4 | 1105 | 60.3 | 75.6 | 95.4 |
| W | \| | 1106 | 93.4 | 1108 | 64.6 | 74.7 | 81.2 |
| N | \| | 1201 | 113.7 | 1202 | 73.4 | 86.6 | 100.9 |
| E | ↓ | 1202 | 116.4 | 1203 | 73.4 | 85.7 | 99.5 |
| S | SBT | 1205 | 103.7 | 1205 | 62.4 | 79.6 | 100.2 |
| W | CBT | 1206 | 120.8 | 1207 | 72.4 | 86.0 | 92.0 |
| N | SBT | 1301 | 112.7 | 1302 | 76.4 | 91.4 | 105.0 |
| E | \| | 1303 | 117.3 | 1304 | 73.4 | 85.3 | 98.2 |
| S | SBT | 1306 | 106.4 | 1306 | 62.4 | 81.2 | 102.4 |
| W | CBT | 1307 | 113.5 | 1308 | 72.4 | 88.0 | 94.4 |
| N | CBT | 1401 | 122.1 | 1402 | 76.4 | 91.4 | 110.4 |
| E | SBT | 1403 | 117.7 | 1404 | 77.5 | 91.9 | 103.7 |
| S | SBT | 1406 | 107.9 | 1406 | 60.3 | 78.1 | 101.3 |
| W | CBT | 1407 | 146.1 | 1408 | 76.1 | 96.0 | 103.7 |
| N | CBT | 1501 | 122.3 | 1502 | 82.3 | 99.5 | 124.9 |
| E | SBT | 1503 | 118.4 | 1504 | 81.5 | 98.6 | 110.0 |
| S | CBT | 1506 | 117.1 | 1505 | 64.5 | 83.8 | 108.0 |
| W | \| | 1508 | 123.3 | 1508 | 72.4 | 93.4 | 100.5 |
| N | CBT | 1600 | 127.8 | 1600 | 79.3 | 94.6 | 121.9 |
| E | SBT | 1601 | 119.8 | 1601 | 81.5 | 100.6 | 112.9 |
| S | CBT | 1603 | 120.3 | 1603 | 68.8 | 88.1 | 115.1 |
| W | CBT | 1604 | 123.6 | 1605 | 83.3 | 115.6 | 133.1 |

DATE: JULY 24, 1978 (205)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0801 | 115.8 | 0802 | 73.4 | 89.1 | 103.2 |
| E | | 0803 | 112.8 | 0804 | 69.2 | 90.8 | 101.4 |
| S | | 0805 | 92.7 | 0805 | 64.5 | 76.6 | 87.8 |
| W | | 0806 | 80.5 | 0807 | 60.4 | 71.7 | 80.5 |
| N | | 0901 | 108.5 | 0901 | 70.4 | 84.2 | 99.6 |
| E | | 0902 | 113.0 | 0903 | 69.2 | 88.5 | 100.6 |
| S | | 0905 | 93.3 | 0905 | 60.3 | 73.7 | 88.4 |
| W | | 0906 | 80.1 | 0907 | 55.9 | 65.2 | 71.8 |
| N | | 1001 | 104.5 | 1001 | 70.4 | 83.3 | 98.4 |
| E | | 1002 | 109.4 | 1003 | 69.2 | 85.8 | 99.6 |
| S | | 1005 | 95.3 | 1005 | 60.3 | 75.2 | 93.0 |
| W | | 1006 | 80.5 | 1007 | 60.4 | 70.5 | 77.0 |
| N | | 1102 | 102.2 | 1103 | 73.4 | 88.1 | 101.9 |
| E | | 1104 | 105.8 | 1105 | 69.2 | 82.7 | 97.4 |
| S | | 1107 | 99.4 | 1106 | 58.1 | 72.7 | 93.0 |
| W | SBT | 1108 | 85.5 | 1109 | 64.6 | 75.4 | 81.6 |
| N | CBT | 1201 | 101.9 | 1202 | 67.4 | 79.4 | 91.6 |
| E | SBT | 1203 | 105.4 | 1204 | 64.7 | 74.9 | 91.1 |
| S | SBT | 1206 | 103.0 | 1205 | 58.1 | 74.0 | 95.8 |
| W | CBT | 1207 | 86.9 | 1208 | 64.6 | 75.7 | 82.6 |
| N | | 1301 | 107.6 | 1302 | 67.4 | 80.3 | 94.9 |
| E | | 1303 | 107.9 | 1309 | 73.4 | 86.5 | 100.5 |
| S | | 1312 | 107.5 | 1311 | 62.4 | 81.2 | 101.3 |
| W | | 1313 | 94.4 | 1314 | 72.4 | 88.5 | 94.9 |
| N | | 1401 | 110.3 | 1402 | 70.4 | 85.2 | 102.8 |
| E | | 1402 | 110.0 | 1403 | 73.4 | 86.5 | 101.4 |
| S | | 1405 | 114.1 | 1405 | 62.4 | 80.7 | 102.1 |
| W | | 1406 | 113.3 | 1407 | 72.4 | 90.9 | 97.6 |
| N | CBT | 1502 | 98.5 | 1503 | 73.4 | 85.0 | 106.1 |
| E | SBT | 1504 | 120.3 | 1505 | 73.4 | 88.1 | 120.3 |
| S | CBT | 1507 | 124.0 | 1507 | 64.5 | 84.3 | 108.6 |
| W | | 1509 | 97.9 | 1511 | 68.5 | 86.8 | 91.3 |
| N | | 1600 | 133.0 | 1600 | 88.1 | 104.0 | 135.0 |
| E | | 1601 | 120.1 | 1602 | 81.5 | 97.1 | 114.8 |
| S | | 1604 | 111.3 | 1604 | 68.8 | 84.9 | 110.0 |
| W | CBT | 1605 | 97.9 | 1607 | 68.5 | 87.1 | 87.8 |

DATE: JULY 25, 1978 (206)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0802 | 130.6 | 0803 | 82.3 | 102.8 | 125.2 |
| E | " | 0804 | 110.9 | 0805 | 77.5 | 106.8 | 112.6 |
| S | " | 0807 | 96.2 | 0806 | 68.8 | 83.1 | 93.3 |
| W | " | 0808 | 83.4 | 0809 | 64.6 | 77.3 | 80.3 |
| N | " | 0901 | 120.8 | 0903 | 82.3 | 101.5 | 118.6 |
| E | " | 0916 | 109.6 | 0917 | 81.5 | 111.4 | 116.2 |
| S | " | 0919 | 100.1 | 0919 | 60.3 | 75.6 | 90.0 |
| W | " | 0921 | 82.6 | 0921 | 64.6 | 77.3 | 80.0 |
| N | " | 1001 | 110.5 | 1002 | 70.4 | 85.7 | 100.6 |
| E | " | 1003 | 107.0 | 1004 | 73.4 | 93.2 | 104.7 |
| S | " | 1005 | 102.4 | 1005 | 60.3 | 75.6 | 93.3 |
| W | SBT | 1007 | 82.7 | 1007 | 60.4 | 70.8 | 77.2 |
| N | CBT | 1101 | 104.0 | 1102 | 67.4 | 81.6 | 91.8 |
| E | SBT | 1103 | 105.6 | 1104 | 64.7 | 77.9 | 93.9 |
| S | " | 1106 | 105.3 | 1106 | 58.1 | 73.6 | 93.8 |
| W | SBT | 1107 | 84.0 | 1108 | 55.9 | 64.3 | 75.6 |
| N | CBT | 1201 | 88.5 | 1202 | 57.9 | 68.0 | 77.7 |
| E | CBT | 1202 | 82.0 | 1204 | 59.9 | 69.0 | 81.0 |
| S | SBT | 1205 | 99.8 | 1205 | 53.8 | 68.2 | 91.1 |
| W | CBT | 1206 | 89.3 | 1207 | 60.4 | 71.1 | 78.4 |
| N | " | 1301 | 51.5 | 1302 | 38.4 | 42.4 | 49.0 |
| E | " | 1303 | 80.8 | 1304 | 54.7 | 62.3 | 74.8 |
| S | " | 1306 | 111.7 | 1305 | 62.4 | 81.2 | 101.3 |
| W | " | 1307 | 82.9 | 1308 | 60.4 | 72.5 | 78.3 |
| N | " | 1401 | 92.1 | 1402 | 64.3 | 75.9 | 91.4 |
| E | " | 1403 | 84.2 | 1404 | 59.9 | 67.2 | 80.4 |
| S | " | 1406 | 108.8 | 1405 | 58.1 | 71.8 | 89.7 |
| W | " | 1407 | 91.6 | 1408 | 60.4 | 73.9 | 77.2 |
| N | " | 1501 | 72.5 | 1501 | 47.3 | 53.5 | 65.1 |
| E | " | 1502 | 89.7 | 1503 | 59.9 | 69.5 | 82.9 |
| S | " | 1504 | 98.7 | 1504 | 55.9 | 71.3 | 91.1 |
| W | " | 1509 | 104.7 | 1510 | 68.5 | 87.8 | 92.7 |
| N | " | 1600 | 91.3 | 1600 | 67.4 | 72.2 | 90.8 |
| E | " | 1601 | 111.7 | 1602 | 77.5 | 91.0 | 107.5 |
| S | " | 1603 | 100.2 | 1603 | 66.7 | 78.6 | 103.0 |
| W | CBT | 1604 | 97.3 | 1605 | 68.5 | 84.9 | 84.3 |

| DATE: JULY 27, 1978 (208) | | | | | | | |
|---|---|---|---|---|---|---|---|
| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
| N | SBT | 0818 | 94.7 | 0823 | 64.3 | —— | —— |
| E | SBT | 0825 | 98.8 | 0828 | 73.4 | —— | —— |
| S | CBT | 0831 | 77.4 | 0832 | 51.6 | —— | —— |
| W | CBT | 0834 | 63.9 | 0836 | 68.5 | | |
| N | SBT | 0901 | 91.0 | 0905 | 67.4 | 83.3 | 95.6 |
| E | SBT | 0904 | 101.9 | 0908 | 73.4 | 99.3 | 108.0 |
| S | CBT | 0910 | 79.0 | 0912 | 53.8 | 67.4 | 82.3 |
| W | CBT | 0911 | 65.6 | 0915 | 55.9 | 65.9 | 66.8 |
| N | SBT | 1001 | 84.3 | 1004 | 67.4 | 82.5 | 97.7 |
| E | SBT | 1005 | 96.0 | 1007 | 69.2 | 88.5 | 101.5 |
| S | CBT | 1013 | 84.1 | 1009 | 53.8 | 68.6 | 83.0 |
| W | CBT | 1010 | 66.0 | 1012 | 55.9 | 65.7 | 70.9 |
| N | SBT | 1102 | 83.8 | 1103 | 61.2 | 73.6 | 90.4 |
| E | SBT | 1105 | 89.8 | 1106 | 73.4 | 92.0 | 104.1 |
| S | CBT | 1110 | 87.8 | 1108 | 55.9 | 73.8 | 89.9 |
| W | CBT | 1111 | 74.2 | 1113 | 60.4 | 71.9 | 77.9 |
| N | SBT | 1202 | 84.0 | 1203 | 70.4 | 86.6 | 100.9 |
| E | SBT | 1204 | 90.2 | 1205 | 69.2 | 83.0 | 97.4 |
| S | CBT | 1209 | 92.8 | 1207 | 55.9 | 74.2 | 91.1 |
| W | CBT | 1210 | 70.4 | 1211 | 60.4 | 72.2 | 79.4 |
| N | SBT | 1303 | 82.3 | 1303 | 67.4 | 81.6 | 97.4 |
| E | SBT | 1306 | 89.9 | 1307 | 69.2 | 81.7 | 95.1 |
| S | CBT | 1310 | 92.3 | 1308 | 60.3 | 82.4 | 103.0 |
| W | ↑ | 1312 | 48.6 | 1314 | 51.1 | 60.2 | 65.5 |
| N | \| | 1402 | 90.0 | 1402 | 70.4 | 84.7 | 102.8 |
| E | ↓ | 1405 | 89.8 | 1405 | 77.5 | 92.8 | 108.3 |
| S | CBT | 1409 | 83.9 | 1411 | 53.8 | 66.7 | 82.7 |
| W | —— | —— | —— | —— | —— | —— | —— |
| N | CBT | 1516 | 125.7 | 1517 | 94.0 | 96.3 | 120.8 |
| E | SBT | 1518 | 109.7 | 1518 | 89.3 | 93.2 | 104.1 |
| S | CBT | 1522 | 152.4 | 1520 | 88.6 | 106.2 | 138.2 |
| W | —— | —— | —— | —— | —— | —— | —— |
| N | CBT | 1604 | 151.5 | 1605 | 94.0 | 109.0 | 142.0 |
| E | \| | 1606 | 134.2 | 1606 | 93.1 | 97.3 | 115.0 |
| S | CBT | 1608 | 130.3 | 1606 | 62.4 | 81.6 | 106.8 |
| W | —— | —— | —— | —— | —— | —— | —— |

DATE: JULY 28, 1978 (209)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | CBT | 0802 | 89.9 | 0804 | 73.4 | 88.1 | 89.9 |
| E | ↑ | 0807 | 82.9 | 0807 | 73.4 | 99.0 | 104.6 |
| S | | 0812 | 128.2 | 0810 | 79.7 | 88.4 | 104.9 |
| W | | 0813 | 59.1 | 0814 | 55.9 | 65.7 | 60.3 |
| N | | 0905 | 72.1 | 0906 | 64.3 | 77.5 | 82.6 |
| E | | 0907 | 83.5 | 0908 | 64.7 | 82.8 | 88.4 |
| S | | 0911 | 93.1 | 0910 | 62.4 | 80.7 | 97.6 |
| W | | 0914 | 51.3 | 0916 | 51.1 | 58.6 | 62.2 |
| N | | 1005 | 106.4 | 1006 | 82.3 | 103.5 | 119.3 |
| E | | 1007 | 91.2 | 1007 | 73.4 | 97.0 | 106.2 |
| S | ↓ | 1010 | 97.8 | 1009 | 60.3 | 79.0 | 96.1 |
| W | CBT | 1011 | 57.7 | 1012 | 55.9 | 65.9 | 71.1 |
| N | SBT | 1103 | 84.2 | 1104 | 76.4 | 95.3 | 107.6 |
| E | CBT | 1105 | 109.5 | 1106 | 81.5 | 105.5 | 117.2 |
| S | SBT | 1108 | 93.6 | 1107 | 60.3 | 81.0 | 99.9 |
| W | CBT | 1110 | 71.0 | 1110 | 60.4 | 71.9 | 77.9 |
| N | CBT | 1201 | 77.9 | 1202 | 70.4 | 84.7 | 98.1 |
| E | SBT | 1204 | 101.9 | 1205 | 73.4 | 90.1 | 102.9 |
| S | SBT | 1208 | 90.7 | 1207 | 53.8 | 70.9 | 93.3 |
| W | CBT | 1209 | 72.5 | 1210 | 60.4 | 73.3 | 80.4 |
| N | CBT | 1259 | 72.5 | 1300 | 61.2 | 79.7 | 88.1 |
| E | SBT | 1301 | 92.4 | 1301 | 73.4 | 89.3 | 101.7 |
| S | CBT | 1306 | 97.4 | 1303 | 60.3 | 80.0 | 99.7 |
| W | \| | 1308 | 73.3 | 1308 | 64.6 | 81.4 | 87.5 |
| N | CBT | 1402 | 70.2 | 1402 | 64.3 | 73.5 | 88.4 |
| E | SBT | 1402 | 94.9 | 1405 | 73.4 | 87.7 | 99.6 |
| S | CBT | 1408 | 102.3 | 1407 | 68.8 | 85.6 | 108.9 |
| W | ↑ | 1409 | 87.5 | 1408 | 72.4 | 88.9 | 95.2 |
| N | | 1515 | 53.4 | 1515 | — | — | — |
| E | | 1503 | 88.3 | 1503 | 69.2 | 80.6 | 95.5 |
| S | | 1507 | 79.7 | 1506 | 49.4 | 63.8 | 81.0 |
| W | | 1510 | 85.0 | 1510 | 60.4 | 70.8 | 69.1 |
| N | | 1556 | 84.5 | 1557 | 67.4 | 68.9 | 86.2 |
| E | ↓ | 1558 | 102.3 | 1556 | 77.5 | 89.2 | 105.3 |
| W | CBT | — | — | 1601 | 72.4 | 73.3 | 65.9 |
| | | | | | | | |

DATE: JULY 29, 1978 (210)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | CBT | 0807 | 81.6 | 0808 | 67.4 | 83.3 | —— |
| E | \| | 0809 | 94.5 | 0810 | 69.2 | 95.5 | 100.5 |
| S | CBT | 0812 | 73.0 | 0813 | 55.9 | 64.3 | |
| W | SBT | 0814 | 66.4 | 0813 | 53.8 | 64.0 | 69.8 |
| N | CBT | 0902 | 84.5 | 0902 | 70.4 | 89.0 | 99.4 |
| E | ↑ | 0904 | 95.0 | 0905 | 69.2 | 93.5 | 100.3 |
| S | | 0908 | 70.1 | 0908 | 51.6 | 63.7 | 78.0 |
| W | | 0909 | 58.7 | 0910 | 51.1 | 58.8 | 62.4 |
| N | | 1003 | 82.8 | 1004 | 70.4 | 86.1 | 96.0 |
| E | | 1006 | 95.5 | 1006 | 69.2 | 88.8 | 97.4 |
| S | | 1008 | 74.1 | 1008 | 51.6 | 65.4 | 78.9 |
| W | | 1010 | 70.6 | 1010 | 64.6 | 78.0 | 79.5 |
| N | ↓ | 1103 | 86.4 | 1103 | 70.4 | 87.1 | 98.8 |
| E | CBT | 1105 | 90.1 | 1105 | 69.2 | 86.1 | 96.8 |
| S | SBT | 1108 | 76.1 | 1108 | 51.6 | 67.1 | 88.4 |
| W | CBT | 1109 | 68.4 | 1109 | 60.4 | 71.9 | 77.9 |
| N | ↑ | 1202 | 89.3 | 1202 | 70.4 | 84.7 | 98.1 |
| E | | 1204 | 81.7 | 1204 | 64.7 | 77.9 | 90.3 |
| S | | 1206 | 78.9 | 1206 | 55.9 | 75.5 | 92.9 |
| W | | 1207 | 70.3 | 1208 | 55.9 | 66.8 | 74.5 |
| N | | 1304 | 66.4 | 1304 | 57.9 | 68.3 | 80.4 |
| E | | 1306 | 92.7 | 1306 | 73.4 | 88.1 | 102.2 |
| S | | 1309 | 66.5 | 1309 | 44.8 | 57.4 | 68.0 |
| W | | 1311 | 74.4 | 1311 | 64.6 | 80.8 | 86.9 |
| N | | 1402 | 74.4 | 1402 | 61.2 | 71.1 | 85.5 |
| E | | 1404 | 84.3 | 1404 | 69.2 | 80.3 | 94.7 |
| S | | 1407 | 71.2 | 1407 | 49.4 | 64.4 | 79.5 |
| W | | 1408 | 90.5 | 1409 | 68.5 | 86.8 | 92.7 |
| N | | 1501 | 96.2 | 1502 | 73.4 | 86.6 | 108.2 |
| E | | 1503 | 68.1 | 1503 | 59.9 | 70.0 | 83.5 |
| S | | 1507 | 100.7 | 1506 | 62.4 | 80.2 | 103.1 |
| W | | 1508 | 96.1 | 1508 | 72.4 | 95.0 | 102.7 |
| N | | 1601 | 92.8 | 1602 | 70.4 | 80.9 | 102.9 |
| E | | 1604 | 77.7 | 1602 | 59.9 | 69.5 | 81.7 |
| S | ↓ | 1606 | 93.9 | 1606 | 62.4 | 76.5 | 100.3 |
| W | CBT | 1608 | 88.5 | 1609 | 68.5 | 94.3 | 99.2 |

| DATE: JULY 30, 1978 (211) | | | | | | | |
|---|---|---|---|---|---|---|---|
| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
| N | SBT | 0811 | 107.1 | 0813 | 79.3 | 99.4 | 120.5 |
| E | ↑ | 0814 | 119.3 | 0815 | 77.5 | 110.3 | 115.1 |
| S | | 0817 | 86.3 | 0817 | 62.4 | 76.5 | 87.7 |
| W | | 0818 | 65.1 | 0819 | 55.9 | 66.4 | 71.7 |
| N | | 0902 | 103.9 | 0904 | 70.4 | 84.7 | 100.1 |
| E | | 0905 | 113.5 | 0907 | 77.5 | 106.4 | 112.8 |
| S | | 0909 | 89.0 | 0909 | 58.1 | 73.6 | 88.3 |
| W | | 0911 | 72.4 | 0913 | 60.4 | 71.9 | 76.4 |
| N | | 1002 | 98.6 | 1004 | 76.4 | 92.5 | 106.8 |
| E | | 1004 | 106.6 | 1005 | 77.5 | 102.9 | 111.4 |
| S | ↓ | 1007 | 92.1 | 1007 | 58.1 | 74.9 | 92.7 |
| W | SBT | 1008 | 75.7 | 1010 | 60.4 | 71.7 | 77.7 |
| N | CBT | 1104 | 107.1 | 1105 | 79.3 | 95.2 | 109.0 |
| E | SBT | 1106 | 104.1 | 1107 | 77.5 | 98.1 | 108.5 |
| S | | 1109 | 96.3 | 1108 | 55.9 | 73.0 | 93.3 |
| W | SBT | 1110 | 81.8 | 1112 | 60.4 | 71.7 | 79.6 |
| N | CBT | 1201 | 115.9 | 1203 | 82.3 | 99.5 | 116.1 |
| E | CBT | 1203 | 103.1 | 1204 | 81.5 | 102.1 | 115.7 |
| S | SBT | 1206 | 107.2 | 1206 | 60.3 | 79.0 | 99.8 |
| W | CBT | 1207 | 88.4 | 1208 | 68.5 | 83.9 | 90.1 |
| N | ↑ | 1301 | 100.8 | 1303 | 67.4 | 80.7 | 95.4 |
| E | | 1303 | 102.8 | 1305 | 77.5 | 94.6 | 109.1 |
| S | | 1309 | 108.6 | 1308 | 60.3 | 81.5 | 101.8 |
| W | | 1310 | 98.9 | 1311 | 68.5 | 84.6 | 90.8 |
| N | | 1402 | 114.9 | 1403 | 73.4 | 88.1 | 106.4 |
| E | | 1404 | 108.4 | 1405 | 77.5 | 93.7 | 109.3 |
| S | | 1407 | 103.3 | 1407 | 62.4 | 85.9 | 109.3 |
| W | | 1408 | 97.1 | 1409 | 68.5 | 88.2 | 94.3 |
| N | | 1501 | 100.3 | 1502 | 76.4 | 92.0 | 115.2 |
| E | | 1503 | 107.7 | 1504 | 73.4 | 88.5 | 104.5 |
| S | | 1506 | 99.5 | 1506 | 55.9 | 73.4 | 93.9 |
| W | ↓ | 1508 | 102.1 | 1509 | 76.1 | 103.7 | 114.8 |
| N | CBT | 1601 | 98.9 | 1603 | 70.4 | 81.9 | 104.3 |
| E | SBT | 1604 | 95.9 | 1605 | 73.4 | 88.5 | 97.7 |
| S | SBT | 1607 | 96.3 | 1607 | 55.9 | 70.9 | 96.5 |
| W | CBT | 1608 | 108.3 | 1609 | 64.6 | 86.8 | 87.3 |

| DATE: JULY 31, 1978 (212) | | | | | | | |
|---|---|---|---|---|---|---|---|
| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
| N | CBT | 0801 | 77.3 | 0803 | 61.2 | 73.6 | —— |
| E | ↑ | 0803 | 108.9 | 0804 | 81.5 | 88.5 | 92.3 |
| S | ↑ | 0806 | 98.9 | 0806 | 58.1 | 78.3 | 94.7 |
| W | ↑ | 0807 | 69.9 | 0808 | 55.9 | 60.5 | 57.3 |
| N | ↑ | 0901 | 84.8 | 0903 | 67.4 | 73.6 | 77.0 |
| E | ↑ | 0903 | 133.0 | 0905 | 93.1 | 96.8 | 104.0 |
| S | ↑ | 0906 | 76.9 | 0906 | 49.4 | 55.2 | 68.2 |
| W | ↑ | 0908 | 62.8 | 0909 | 60.4 | 69.4 | 69.0 |
| N | ↑ | 1001 | 110.8 | 1003 | 82.3 | 92.2 | 109.2 |
| E | ↑ | 1004 | 99.6 | 1005 | 73.4 | 85.7 | 94.1 |
| S | ↑ | 1007 | 81.9 | 1006 | 55.9 | 57.2 | 68.6 |
| W | ↑ | 1008 | 72.9 | 1009 | 64.6 | 71.4 | 74.9 |
| N | ↑ | 1101 | 66.2 | 1103 | 61.2 | 74.6 | 83.0 |
| E | ↑ | 1104 | 81.4 | 1105 | 59.9 | 65.0 | 74.7 |
| S | ↑ | 1107 | 74.3 | 1106 | 44.8 | 54.8 | 64.4 |
| W | ↑ | 1108 | 97.3 | 1109 | 76.1 | 84.4 | 87.8 |
| N | ↑ | 1201 | 142.4 | 1203 | 102.8 | 107.4 | 125.8 |
| E | ↑ | 1202 | 89.0 | 1204 | 69.2 | 64.3 | 76.0 |
| S | ↑ | 1206 | 100.1 | 1205 | 64.5 | 78.3 | 96.8 |
| W | ↑ | 1207 | 87.8 | 1207 | 64.6 | 76.7 | 83.5 |
| N | ↑ | 1301 | 109.5 | 1303 | 79.3 | 95.2 | 112.9 |
| E | ↑ | 1303 | 88.2 | 1304 | 64.7 | 76.4 | 89.8 |
| S | ↑ | 1307 | 88.4 | 1307 | 53.8 | 74.3 | 91.7 |
| W | ↑ | 1310 | 92.2 | 1311 | 72.4 | 95.8 | 102.5 |
| N | ↑ | 1400 | 69.1 | 1402 | 57.9 | 67.1 | 80.5 |
| E | ↑ | 1403 | 104.0 | 1403 | 77.5 | 95.9 | 111.7 |
| S | ↑ | 1406 | 102.7 | 1406 | 58.1 | 79.4 | 100.3 |
| W | ↑ | 1408 | 96.8 | 1408 | 68.5 | 87.8 | 93.9 |
| N | ↑ | 1501 | 97.5 | 1502 | 67.4 | 81.6 | 101.7 |
| E | ↑ | 1502 | 103.2 | 1504 | 73.4 | 88.1 | 104.1 |
| S | ↑ | 1506 | 75.6 | 1505 | 49.4 | 63.8 | 81.0 |
| W | ↑ | 1507 | 96.7 | 1508 | 64.6 | 83.6 | 86.9 |
| N | ↑ | 1600 | 115.7 | 1601 | 79.3 | 95.8 | 123.6 |
| E | ↑ | 1602 | 99.7 | 1603 | 77.5 | 94.6 | 111.8 |
| S | ↑ | 1606 | 89.1 | 1605 | 53.8 | 63.7 | 83.9 |
| W | CBT | 1608 | 96.4 | 1609 | 72.4 | 97.8 | 104.8 |

DATE: AUG. 1, 1978 (213)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | CBT | 0801 | 105.9 | 0802 | 67.4 | 86.3 | 105.9 |
| E | SBT | 0803 | 111.4 | 0804 | 81.5 | 121.2 | 122.7 |
| S | ↑ | 0807 | 80.4 | 0806 | 55.9 | 68.5 | 80.9 |
| W | \| | 0807 | 66.3 | 0808 | 60.4 | 72.8 | 76.7 |
| N | \| | 0902 | 98.2 | 0903 | 67.4 | 85.5 | 101.0 |
| E | \| | 0904 | 109.5 | 0905 | 77.5 | 110.3 | 115.4 |
| S | \| | 0907 | 83.2 | 0906 | 55.9 | 70.9 | 86.0 |
| W | \| | 0908 | 66.8 | 0909 | 60.4 | 71.9 | 76.4 |
| N | \| | 1001 | 91.1 | 1002 | 64.3 | 79.8 | 95.2 |
| E | \| | 1003 | 102.3 | 1005 | 69.2 | 90.2 | 102.7 |
| S | ↓ | 1006 | 86.0 | 1006 | 55.9 | 73.0 | 91.1 |
| W | SBT | 1007 | 68.1 | 1007 | 55.9 | 65.9 | 74.2 |
| N | CBT | 1101 | 89.9 | 1103 | 61.2 | 74.3 | 82.6 |
| E | SBT | 1103 | 91.4 | 1104 | 73.4 | 93.6 | 105.2 |
| S | \| | 1106 | 90.2 | 1106 | 55.9 | 73.8 | 93.9 |
| W | SBT | 1107 | 71.8 | 1109 | 60.4 | 71.7 | 79.6 |
| N | CBT | 1201 | 83.5 | 1202 | 61.2 | 74.7 | 85.9 |
| E | SBT | 1203 | 87.2 | 1204 | 73.4 | 89.7 | 102.1 |
| S | \| | 1207 | 91.3 | 1206 | 55.9 | 74.2 | 95.9 |
| W | SBT | 1208 | 76.6 | 1208 | 64.6 | 78.9 | 85.4 |
| N | CBT | 1301 | 59.3 | 1302 | 54.6 | 65.3 | 76.7 |
| E | SBT | 1303 | 83.1 | 1304 | 64.7 | 77.0 | 91.1 |
| S | CBT | 1307 | 92.3 | 1306 | 55.9 | 76.3 | 94.5 |
| W | \| | 1308 | 83.0 | 1310 | 68.5 | 85.7 | 92.0 |
| N | CBT | 1400 | 61.7 | 1402 | 47.3 | 55.2 | 65.9 |
| E | SBT | 1403 | 83.5 | 1403 | 64.7 | 76.7 | 88.9 |
| S | CBT | 1406 | 73.6 | 1405 | 40.4 | 63.1 | 77.6 |
| W | \| | 1409 | 83.2 | 1409 | 68.5 | 89.3 | 95.7 |
| N | CBT | 1500 | 76.2 | 1502 | 57.9 | 66.7 | 82.3 |
| E | SBT | 1502 | 79.4 | 1503 | 59.9 | 70.0 | 78.6 |
| S | CBT | 1505 | 80.5 | 1505 | 53.8 | 69.0 | 88.0 |
| W | ↑ | 1507 | 81.6 | 1507 | 64.6 | 84.0 | 87.4 |
| N | \| | 1600 | 76.1 | 1601 | 57.9 | 68.3 | 85.8 |
| E | \| | 1602 | 78.6 | 1603 | 69.2 | 79.2 | 93.3 |
| S | ↓ | 1604 | 79.5 | 1604 | 53.8 | 66.7 | 87.7 |
| W | CBT | 1606 | 84.3 | 1607 | 72.4 | 101.1 | 110.1 |

DATE: AUG 3, 1978 (215)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0911 | 108.3 | 0913 | 73.4 | 93.8 | 110.1 |
| E | ↑ | 0914 | 97.8 | 0915 | 73.4 | 100.1 | 108.5 |
| S | ↑ | 0919 | 97.4 | 0918 | 62.4 | 80.2 | 93.9 |
| W | ↑ | 0920 | 76.6 | 0921 | 60.4 | 72.5 | 76.8 |
| N | ↑ | 1008 | 108.2 | 1009 | 73.4 | 92.3 | 106.6 |
| E | ↑ | 1009 | 98.8 | 1011 | 69.2 | 89.8 | 102.4 |
| S | ↑ | 1013 | 95.4 | 1012 | 60.3 | 79.5 | 96.6 |
| W | SBT | 1014 | 76.0 | 1014 | 60.4 | 72.2 | 78.0 |
| N | CBT | 1101 | 109.3 | 1102 | 67.4 | 82.9 | 93.5 |
| E | SBT | 1103 | 100.3 | 1103 | 77.5 | 99.0 | 109.1 |
| S | SBT | 1105 | 97.5 | 1105 | 60.3 | 80.5 | 99.5 |
| W | CBT | 1106 | 79.2 | 1107 | 64.6 | 78.0 | 82.7 |
| N | ↑ | 1201 | 101.6 | 1203 | 67.4 | 83.3 | 96.4 |
| E | CBT | 1203 | 110.4 | 1204 | 81.5 | 102.1 | 115.7 |
| S | SBT | 1207 | 101.1 | 1206 | 58.1 | 78.5 | 99.4 |
| W | CBT | 1209 | 89.1 | 1210 | 68.5 | 83.5 | 89.7 |
| N | ↑ | 1302 | 99.3 | 1303 | 70.4 | 87.5 | 103.6 |
| E | ↑ | 1303 | 104.1 | 1305 | 73.4 | 88.5 | 102.6 |
| S | ↑ | 1307 | 101.3 | 1306 | 60.3 | 82.4 | 103.0 |
| W | ↑ | 1308 | 94.8 | 1309 | 76.1 | 97.3 | 104.1 |
| N | ↑ | 1401 | 99.0 | 1402 | 67.4 | 82.9 | 100.0 |
| E | ↑ | 1403 | 104.8 | 1404 | 77.5 | 92.8 | 108.3 |
| S | ↑ | 1407 | 94.2 | 1406 | 55.9 | 75.1 | 94.3 |
| W | ↑ | 1408 | 101.6 | 1409 | 79.7 | 103.4 | 115.0 |
| N | ↑ | 1501 | 111.3 | 1503 | 76.4 | 94.8 | 118.8 |
| E | ↑ | 1503 | 90.3 | 1504 | 69.2 | 83.0 | 98.3 |
| S | ↑ | 1510 | 103.1 | 1506 | 62.4 | 83.8 | 108.0 |
| W | CBT | 1511 | 108.4 | 1512 | 76.1 | 103.7 | 114.8 |
| N | SBT | 1601 | 117.5 | 1602 | 76.4 | 93.6 | 113.7 |
| E | CBT | 1603 | 100.1 | 1604 | 73.4 | 89.3 | 105.4 |
| S | ↑ | 1606 | 110.2 | 1606 | 64.5 | 83.8 | 109.6 |
| W | CBT | 1607 | 118.5 | 1608 | 83.3 | 118.4 | 137.6 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

DATE: AUG. 4, 1978 (216)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0803 | 110.8 | 0805 | 76.4 | 97.6 | 118.1 |
| E | ↑ | 0805 | 105.9 | 0806 | 77.5 | 111.2 | 115.7 |
| S | | 0808 | 86.8 | 0808 | 60.3 | 73.3 | 84.9 |
| W | | 0809 | 81.7 | 0810 | 68.5 | 83.9 | 85.5 |
| N | | 0902 | 110.2 | 0903 | 73.4 | 91.2 | 107.3 |
| E | | 0904 | 100.5 | 0905 | 77.5 | 109.0 | 114.6 |
| S | | 0907 | 90.4 | 0907 | 64.5 | 83.2 | 96.4 |
| W | | 0908 | 80.3 | 0909 | 64.6 | 78.3 | 80.7 |
| N | | 1004 | 108.2 | 1006 | 73.4 | 91.7 | 106.1 |
| E | | 1007 | 100.3 | 1008 | 77.5 | 102.9 | 111.4 |
| S | | 1010 | 94.7 | 1009 | 60.3 | 78.1 | 95.4 |
| W | | 1011 | 80.5 | 1011 | 68.5 | 82.8 | 84.4 |
| N | | 1101 | 104.9 | 1102 | 73.4 | 90.7 | 103.9 |
| E | | 1103 | 106.9 | 1104 | 81.5 | 104.0 | 112.7 |
| S | | 1106 | 105.2 | 1106 | 62.4 | 82.8 | 101.4 |
| W | | 1110 | 89.5 | 1110 | 68.5 | 82.8 | 85.6 |
| N | | 1205 | 101.3 | 1206 | 73.4 | 91.2 | 104.4 |
| E | | 1208 | 112.5 | 1209 | 81.5 | 99.6 | 110.3 |
| S | ↓ | 1213 | 115.2 | 1213 | 68.8 | 95.8 | 113.2 |
| W | SBT | 1215 | 98.0 | 1217 | 72.4 | 88.9 | 90.4 |
| N | CBT | 1302 | 102.3 | 1303 | 73.4 | 91.2 | 121.5 |
| E | CBT | 1304 | 136.3 | 1305 | 93.1 | 116.3 | 132.1 |
| S | SBT | 1309 | 123.8 | 1308 | 71.0 | 99.5 | 116.6 |
| W | SBT | 1310 | 104.0 | 1311 | 76.1 | 96.4 | 93.2 |
| N | CBT | 1401 | 104.0 | 1402 | 70.4 | 87.1 | 105.1 |
| E | CBT | 1403 | 118.9 | 1404 | 89.3 | 111.6 | 128.8 |
| S | SBT | 1406 | 120.7 | 1406 | 68.8 | 92.9 | 112.0 |
| W | ↑ | 1407 | 107.7 | 1408 | 76.1 | 100.1 | 107.2 |
| N | | 1502 | 105.8 | 1503 | 73.4 | 90.7 | 107.4 |
| E | | 1504 | 108.0 | 1504 | 77.5 | 94.6 | 105.6 |
| S | | 1506 | 119.0 | 1506 | 68.8 | 94.5 | 112.1 |
| W | | 1508 | 111.8 | 1510 | 83.3 | 115.6 | 117.6 |
| N | | 1600 | 130.9 | 1600 | 85.2 | 98.4 | 120.0 |
| E | | 1601 | 106.1 | 1602 | 85.4 | 108.3 | 122.6 |
| S | ↓ | 1604 | 115.7 | 1603 | 68.8 | 91.9 | 108.9 |
| W | SBT | 1605 | 117.2 | 1606 | 83.3 | 119.5 | 127.8 |

| DATE: AUG. 5, 1978 (217) | | | | | | | |
|---|---|---|---|---|---|---|---|
| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
| N | SBT | 0805 | 128.0 | 0807 | 82.3 | 106.1 | 129.6 |
| E | ↑ | 0809 | 128.0 | 0810 | 85.4 | 124.6 | 125.1 |
| S | ↑ | 0811 | 84.6 | 0811 | 60.3 | 72.8 | 84.5 |
| W | ↑ | 0812 | 84.1 | 0815 | 64.6 | 78.6 | 84.1 |
| N | ↑ | 0901 | 119.5 | 0902 | 79.3 | 100.0 | 117.0 |
| E | ↑ | 0903 | 125.0 | 0905 | 81.5 | 113.3 | 117.5 |
| S | ↑ | 0907 | 85.7 | 0906 | 55.9 | 69.7 | 85.0 |
| W | ↑ | 0908 | 83.4 | 0909 | 68.5 | 83.9 | 84.5 |
| N | ↑ | 1000 | 113.6 | 1001 | 73.4 | 90.2 | 104.7 |
| E | ↑ | 1002 | 115.9 | 1003 | 85.4 | 115.4 | 120.0 |
| S | ↑ | 1005 | 84.6 | 1004 | 53.8 | 67.4 | 86.4 |
| W | ↑ | 1006 | 81.3 | 1006 | 64.6 | 77.3 | 81.1 |
| N | ↑ | 1101 | 106.1 | 1102 | 73.4 | 90.2 | 103.5 |
| E | ↑ | 1102 | 108.3 | 1103 | 81.5 | 103.1 | 112.1 |
| S | ↑ | 1105 | 89.1 | 1104 | 58.1 | 75.4 | 95.3 |
| W | ↑ | 1106 | 85.3 | 1107 | 68.5 | 82.8 | 85.6 |
| N | ↑ | 1200 | 98.2 | 1201 | 70.4 | 86.6 | 100.9 |
| E | ↑ | 1202 | 101.6 | 1203 | 77.5 | 94.6 | 106.4 |
| S | ↑ | 1204 | 89.2 | 1204 | 55.9 | 73.0 | 95.0 |
| W | ↑ | 1205 | 99.3 | 1206 | 72.4 | 88.5 | 90.2 |
| N | ↑ | 1300 | 94.8 | 1301 | 64.3 | 78.2 | 94.7 |
| E | ↑ | 1302 | 97.2 | 1303 | 73.4 | 87.3 | 99.9 |
| S | ↑ | 1305 | 93.3 | 1304 | 55.9 | 73.8 | 96.8 |
| W | ↑ | 1306 | 99.6 | 1306 | 76.1 | 96.4 | 93.2 |
| N | ↑ | 1400 | 95.4 | 1401 | 64.3 | 78.2 | 95.1 |
| E | ↑ | 1402 | 93.3 | 1402 | 73.4 | 87.7 | 99.6 |
| S | ↑ | 1404 | 97.4 | 1404 | 58.1 | 77.2 | 100.7 |
| W | ↑ | 1407 | 108.5 | 1408 | 72.4 | 94.6 | 104.4 |
| N | ↑ | 1501 | 96.0 | 1502 | 64.3 | 76.3 | 92.2 |
| E | ↑ | 1503 | 92.0 | 1504 | 73.4 | 88.5 | 98.9 |
| S | ↑ | 1506 | 100.2 | 1505 | 62.4 | 83.8 | 105.1 |
| W | ↑ | 1507 | 113.0 | 1508 | 79.7 | 111.0 | 115.0 |
| N | ↑ | 1600 | 103.9 | 1601 | 76.4 | 92.0 | 111.6 |
| E | ↑ | 1602 | 93.0 | 1602 | 77.5 | 94.6 | 105.4 |
| S | ↓ | 1604 | 100.8 | 1603 | 62.4 | 80.7 | 102.3 |
| W | SBT | 1605 | 111.0 | 1605 | 72.4 | 98.6 | 115.3 |

DATE: AUG. 6, 1978 (218)

| TARGET | SKY | TIME | $V_{rT}$ | TIME | $V_{rP}$ | $V'_{rP}$ | $V''_{rP}$ |
|---|---|---|---|---|---|---|---|
| N | SBT | 0800 | 101.2 | 0801 | 64.3 | 78.2 | 91.7 |
| E | ↑ | 0801 | 85.3 | 0802 | 69.2 | 93.5 | 103.3 |
| S | | 0805 | 75.6 | 0805 | 58.1 | 68.7 | 81.0 |
| W | | 0806 | 70.6 | 0811 | 55.9 | 64.0 | 69.8 |
| N | | 0900 | 97.3 | 0901 | 64.3 | 77.9 | 92.7 |
| E | | 0902 | 77.3 | 0903 | 54.7 | 68.6 | 87.1 |
| S | | 0905 | 78.3 | 0904 | 51.6 | 62.6 | 78.9 |
| W | | 0906 | 74.3 | 0907 | 51.1 | 58.1 | 67.0 |
| N | | 1001 | 92.5 | 1002 | 61.2 | 73.6 | 89.6 |
| E | | 1003 | 94.5 | 1005 | 69.2 | 89.2 | 102.0 |
| S | | 1007 | 81.8 | 1006 | 51.6 | 63.7 | 83.2 |
| W | | 1008 | 71.4 | 1008 | 55.9 | 64.5 | 73.4 |
| N | | 1100 | 89.2 | 1102 | 57.9 | 68.6 | 86.5 |
| E | ↓ | 1102 | 82.6 | 1104 | 59.9 | 71.5 | 89.3 |
| S | SBT | 1106 | 88.7 | 1106 | 55.9 | 72.2 | 92.6 |
| W | SBT | 1107 | 75.7 | 1109 | 55.9 | 64.7 | 75.8 |
| N | CBT | 1202 | 75.0 | 1208 | 51.0 | 59.6 | 86.2 |
| E | SBT | 1209 | 83.7 | 1210 | 59.9 | 69.5 | 86.9 |
| S | \| | 1213 | 91.3 | 1212 | 51.6 | 67.5 | 90.6 |
| W | SBT | 1214 | 80.6 | 1215 | 64.6 | 77.3 | 84.6 |
| N | CBT | 1300 | 50.5 | 1301 | 47.3 | 53.7 | 62.7 |
| E | CBT | 1302 | 84.1 | 1302 | 69.2 | 81.7 | 95.4 |
| S | SBT | 1305 | 96.9 | 1305 | 53.8 | 69.0 | 93.1 |
| W | CBT | 1307 | 74.7 | 1308 | 58.5 | 85.7 | 92.0 |
| N | \| | 1401 | 57.3 | 1401 | 43.2 | 47.8 | 56.8 |
| E | CBT | 1402 | 87.2 | 1402 | 64.7 | 73.6 | 87.4 |
| S | SBT | 1405 | 88.7 | 1405 | 53.8 | 68.2 | 94.2 |
| W | CBT | 1408 | 80.5 | 1409 | 64.6 | 77.6 | 81.6 |
| N | ↑ | 1501 | 59.4 | 1502 | 47.3 | 42.8 | 51.2 |
| E | | 1503 | 73.9 | 1504 | 64.7 | 69.0 | 82.3 |
| S | | 1506 | 87.4 | 1505 | 55.9 | 68.5 | 87.3 |
| W | | 1507 | 87.9 | 1508 | 76.1 | 97.8 | 106.6 |
| N | | 1600 | 71.2 | 1601 | 47.3 | 50.7 | 60.9 |
| E | | 1602 | 89.2 | 1603 | 69.2 | 76.5 | 90.1 |
| S | ↓ | 1604 | 119.1 | 1604 | 75.3 | 86.4 | 113.0 |
| W | CBT | 1607 | 100.8 | 1608 | 76.1 | 92.3 | 96.1 |